INTERAVIA

WORLD REVIEW OF AVIATION AND ASTRONAUTICS

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Mobility in Global War

The Tactics of Low-Level Bombing

VOLUME XIV

No 3/1959

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CONVAIR
A DIVISION OF GENERAL DYNAMICS CORPORATION

Volume XIV

INTERAVIA

March 1959

WORLD REVIEW OF AVIATION AND ASTRONAUTICS

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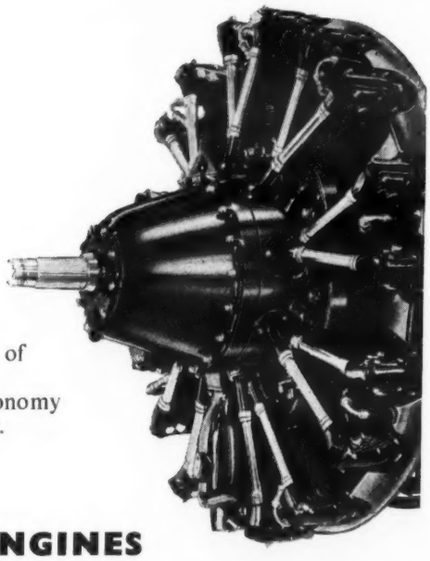
Front cover: The Blackburn and General Aircraft NA. 39 two-seat carrier-borne low-level strike aircraft (powerplant: two de Havilland *Gyron Juniors*) is regarded as the forerunner of a new generation of military aircraft.



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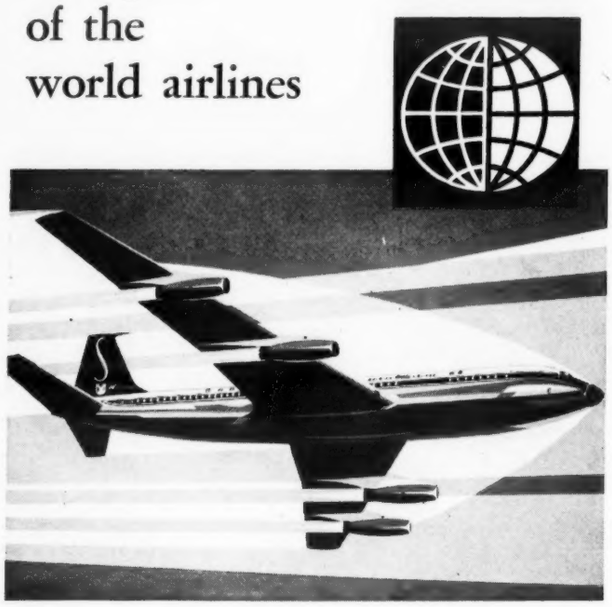

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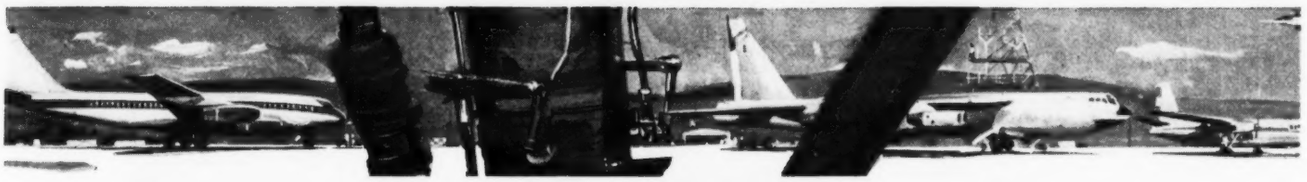

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For complete information, write: Goodyear International Corporation, Aviation Products Division, Akron 16, Ohio, U.S.A., or The Goodyear Tyre & Rubber Company (Great Britain) Ltd., Wolverhampton, England.

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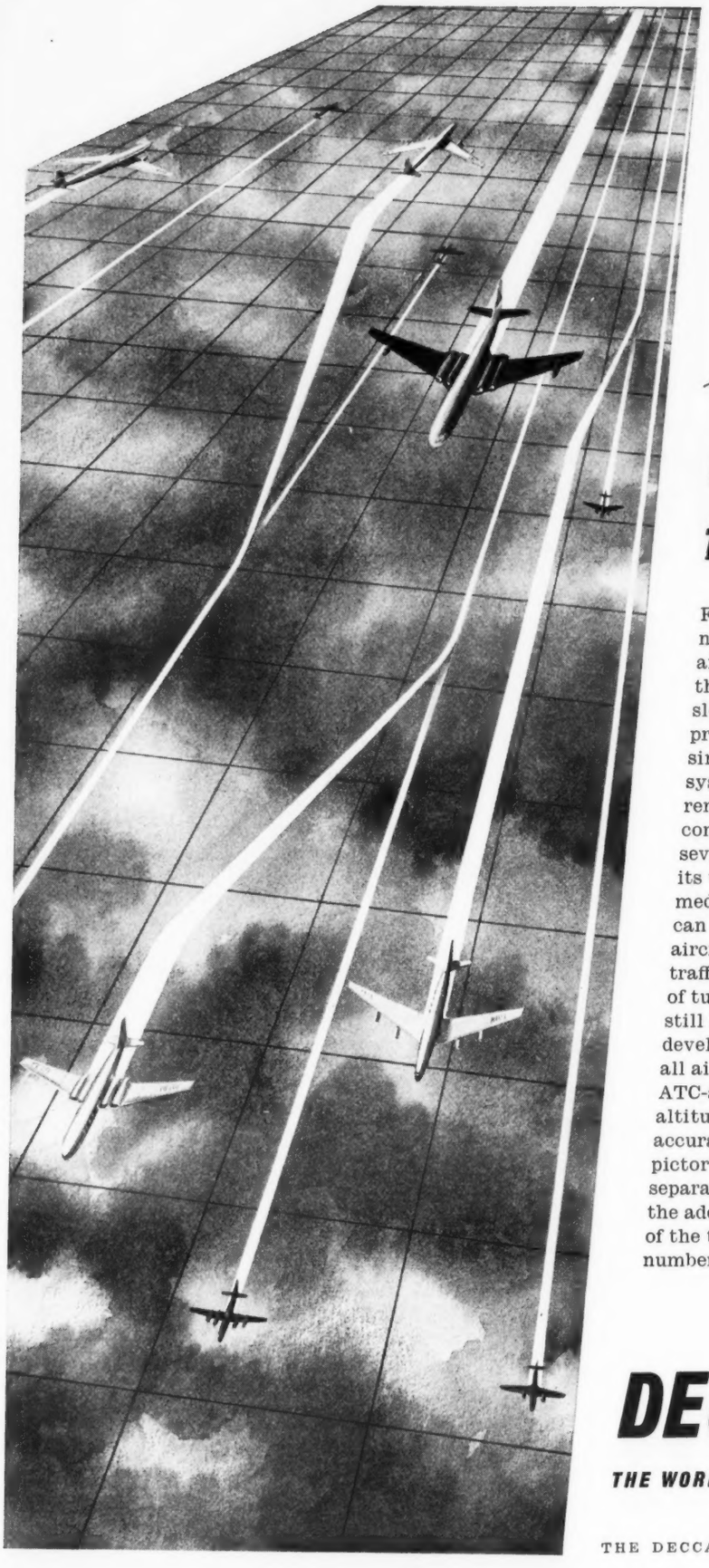

NAVIGATION for the JET AGE

From the dawn of aviation nothing fundamentally new has been added to the earliest principles of air traffic control. Until now these were founded on the requirements and limitations of relatively slow aircraft for which altitude separation was practical. Aircraft speeds and performance have since improved beyond recognition, but the basic system of navigation and air traffic control has remained virtually unchanged. Single tracks and common points of intersection are only two of the severe restrictions imposed on air traffic, threatening its very existence. The air, intrinsically a free medium, is swiftly becoming overcrowded and safety can only be maintained at the expense of inefficient aircraft operation, delays and over complicated air traffic control . . . a condition which the introduction of turbo-prop and turbo-jet aircraft will aggravate still further. Yet the answer exists today in a fully developed form. The Decca Navigator System enables all aircraft to navigate accurately and maintain any ATC-assigned track with precision, regardless of altitude, speed or weather conditions. This very accurate hyperbolic area coverage system, with its pictorial presentation, makes the introduction of lateral separation and "passing lanes" a reality. It is only by the adoption of such a system that full use can be made of the total air space, enabling the rapidly increasing numbers of aircraft to operate with safety and economy.

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●

Seven Australian airlines, the Department of Civil Aviation, and the Aero Club Federation of Australia have reached an agreement on the inauguration of a special airline pilot training scheme to be organized by the ACFA and guaranteeing employment to successful trainees. The first course, scheduled to begin on May 1st, 1959 and lasting two years, will include a ground training syllabus with 350 hours of lectures and 35 hours on the Link Trainer ; the flying course will involve 180 hours instruction on single and twin-engine aircraft, instrument flying, and training in the use of radio aids. The early stages of ground training will be by correspondence, with initial flying at local aero clubs, but the trainees will be required to spend the last four months at Bankstown Airport, NSW. Trainees, who will be in the 17 to 23 years age group, will pay approximately £2,000 for the course, but arrangements are being made for extended payments. The airlines coöperating in this scheme are Qantas, Ansett-ANA, Trans-Australia, Butler, East-West, MacRobertson-Miller, and Queensland.

●

Trans-World Airlines' London Office announces that the airline has received the first of its Boeing 707-120 jet airliners. The new jetliner arrived at TWA's Kansas City maintenance base after a record flight of only two hours, 48 minutes from Seattle. It is being used at present to train both flight crew and ground personnel before the introduction of Boeing jets on TWA's network of domestic routes. From March onward, selected maintenance personnel from the airline's international bases will be flown to the United States for a two-month course in the servicing and ground handling of jet airliners.

●

Pan American World Airways will open a New York-London-Amsterdam-Frankfurt jet service in September 1959 using the Boeing 707 aircraft, according to a statement by the carrier's representative in Amsterdam.

●

Pan American World Airways has reached an agreement with the Air Line Pilots' Association ending a long dispute following the advent of jet airliners. Under the new agreement, the captain of a jet airliner will receive more than $29,000 per year for 80 hours per month flying time. The current rate for piston engine aircraft pilots is $22,000 per year. As far as the question of the " third man " is concerned, Pan American's jet airliners will also carry a third pilot who will act as navigator, and the status of flight engineers remains unchanged.

●

The Civil Aeronautics Board has received a proposal from American Airlines to operate non-stop jet services between Los Angeles and Miami, Florida, using the Boeing 707. Flight time would be 4 hours, 45 minutes.

●

Northeast Airlines, one of the last of the United States domestic trunk lines to receive an airmail subsidy, has been notified by the Civil Aeronautics Board that the subsidy has been terminated. Northeast will, however, receive $4,086,884 in subsidies already due (for the period February 7th, 1957 to December 31st, 1958). Northeast was primarily a New England carrier until awarded a New York-Florida route in September 1956 in competition with National Airlines and Eastern Air Lines.

●

Pacific Western Airlines, of Alberta, has applied for a licence to operate passenger services on the Vancouver-Victoria-Seattle route, which Trans-Canada Air Lines is willing to give up. Pacific Western is also expected to apply for the network of northern routes now operated by Canadian Pacific Airlines out of Edmonton. These extend to Dawson in the Yukon, Fort McPherson and Inuvik in the Arctic, and east to Yellowknife and Uranium City.

●

Aer Lingus has been granted unrestricted traffic rights on the route Zurich-Paris by the French and Swiss authorities ; scheduled services will be inaugurated in April of this year. Aer Lingus will operate the route with *Viscount 880s.* Existing Aer Lingus services from Zurich to Dublin, Manchester and Rome will not be affected.

●

Flugleidir, North Atlantic Aviation is the title of an aviation company established in Iceland with headquarters in the Terminal Building at Keflavik Airport. The company is active in representation of foreign carriers, aircraft maintenance at Keflavik and Reykjavik Airports, flight watch and dispatch for air transport companies, a ground and flight training school, and air charter work. Chairman of the Board and Commercial Director is Asgrimur Palsson ; Skapti Thoroddson is Director of Operations, and Marino Johannson is Director of Training.

●

KLM Royal Dutch Airlines is the first of the international carriers to introduce a " Fly today, pay tomorrow " credit travel plan on to the Swiss market. W. Boissevain, KLM Manager for French-speaking Switzerland, said at a press conference in Geneva that the system is parallel to the deferred payment system for air travel which is already available to North and South America, England, France, Belgium, the Netherlands, Spain, Portugal and South Africa. Down payment will be 15 percent of the ticket price, with the balance payable in three to eighteen monthly instalments at an interest rate of 0.75 percent per month. Credit facilities are being provided by IFM (Société Internationale de Financement des Transports et du Commerce) of Zurich, but tickets will be obtainable normally from travel agents.

●

Società Aviolinee Siciliane is a new company founded in Catania with the object of developing local air services.

●

Turany Airport, serving Brno, Czechoslovakia, now has a 2,190-yard long and 200-foot wide concrete runway and modern air traffic control equipment. The airport is now in a position to handle Tu-104 jet transports.

●

The British Minister of Defence has announced that a decision has finally been taken on a long-range freighter for the RAF : an order will be placed for Short Brothers & Harland's *Britannic 3* powered by Rolls-Royce *Tynes.* The initial order will probably be for about twelve aircraft. Thus the long controversy as to which firm would get the heavy freighter order has been decided. Other competing firms for the contract were Blackburn & General Aircraft Ltd. with the B-107A, Handley Page Ltd. with the HP.111 and Vickers with a military version of the VC-10. *Interavia's* London Editor comments that Short will undoubtedly collaborate with Bristol on the project, and a good deal of work will be done at Filton ; however, Short will handle the overall project and the production side.

●

Rolls-Royce Associates Ltd. is a new company which has been formed to develop nuclear engineering projects, including apparatus for the nuclear propulsion of cars, ships, aircraft and rockets. The new company has a nominal capital of £250,000 in £1 shares and is controlled by Rolls-Royce Ltd. (52 percent), Vickers Ltd. (24 percent) and Foster Wheeler Ltd. (24 percent).

●

The Belgian Air Force has awarded Société Anonyme Belge de Constructions Aéronautiques contracts for the overhaul and maintenance of fourteen Lockheed T-33 and forty Avro CF-100 aircraft. The company has also received similar contracts from the USAF for work on twenty-two DHC L-20 *Beaver,* sixteen DHC U-1, and fifty Sikorsky H-34 aircraft.

●

The Swiss Government has now confirmed the terms of an agreement between the Military Department and the Flug- und Fahrzeugwerke Altenrhein to clear up outstanding matters in connection with the cancelled contract for production of the P-16. As well as dealing with the question of compensation, the agreement authorizes the transfer to FFA of the materials already ordered by the Government in connection with the contract. This will permit FFA to complete the pre-production series of three aircraft, but this work and flight testing will be the responsibility of the company.

●

Aeronoleggi Alessandria Aeral is a new aircraft hire company established in Alessandria (Piedmont), with a fleet of twin-engined Aer Macchi MB.320s.

Aerojet-General Corporation has established an Anti-Submarine Warfare Division to handle a multi-million dollar contract recently awarded to the company for development and production of a new type anti-submarine torpedo, and to expand the company's basic research in anti-submarine warfare detection, underwater communications, weapons systems, ocean surveillance and related activities. The new division will be managed by Calvin A. Gongwer. The technical direction of the torpedo contract is under the Naval Ordnance Test Station, Pasadena, Calif. The Pacific Division of Bendix Aviation Corporation will provide the guidance system.

●

Esso Research and Engineering Company has formed a new unit to develop improved solid propellants for missiles, and both petroleum-based and non-petroleum materials will be utilized. The unit will be headed by Dr. John P. Longwell, assisted by Dr. John F. Kolfenbach. The new unit will work on a $1,264,000 U.S. Army Ordnance Corps contract.

●

The Radio Corporation of America has established a new Missile and Surface Radar Division which will carry out a substantial portion of the company's defence contracts, including the construction of the Ballistic Missile Early Warning System for the Arctic. Harry R. Wege will be General Manager with the new division, which will consist of two RCA plants, one in Moorestown, N.J., and another in the Los Angeles area ; both were formerly under the Defense Electronic Products Division.

●

A $50,731,000 Army contract has been awarded to Raytheon Manufacturing Company for production of the *Hawk* ground-to-air missile system. Of this total, $33,296,000 is for ground equipment and $17,435,000 for production of the *Hawk* missile. Raytheon will carry out the work at the company's Andover, Mass., plant, and about 55 percent of the total contract will be passed to sub-contractors.

●

Thiokol Chemical Corporation has announced that the first solid-propellant development motors in the Army's *Pershing* missile system programme have been successfully test fired. The Martin Company, Orlando, Florida, is the prime contractor for the *Pershing* system, and Thiokol's Redstone Division is developing the solid-propellant propulsion system under subcontract to The Martin Company.

●

Sylvania Electric Products, Inc. and General Telephone Corporation have merged to form General Telephone & Electronics Corporation. Donald C. Power, General Telephone President, will be Chairman and Chief Executive Officer of the new company and Don G. Mitchell, Sylvania Chairman, will be President.

●

Scandinavian Airlines System has negotiated a $49 million loan with United States banks and insurance companies to finance the jet transports it has on order. A total of $33 million was put up by a consortium of banks headed by the First National City Bank of New York, and $16 million were provided by two insurance companies.

●

Deutsche Lufthansa is to receive a DM 19,000,000 operating subsidy from the German Federal Government for the fiscal year commencing April 1st, 1959. Members of the Federal Government Transport Commission doubt, however, whether the subsidy will in fact cover Lufthansa's requirements.

Workshop Briefs

Svenska Aeroplan AB has taken a new series configuration of the Saab-35A *Draken* into production. It differs from the earlier 35A in having a lengthened aft fuselage and a retractable dual tail-wheel landing gear instead of the earlier bumper. The lengthened aft fuselage reduces drag at supersonic speed, while the tail wheel facilitates landing with high nose position for aerodynamic braking.

●

Pioneer Parachute Company and the Parachute Club of America are considering the possibility of carrying out the first "live" tests of Pioneer's new Vortex Ring Parachute (cf. No. 2, 1959, p. 191).

●

The Short Britannic 3, as ordered for the RAF, has a design take-off weight of 195,000 lb. ; a maximum payload of 75,000 lb. can be carried over a range of 1,400 miles at an average speed of 360 m.p.h. With capacity fuel a payload of 30,000 lb. can be carried 5,500 miles. Span is 148 ft. 3.5 in. ; length 134 ft. ; and height 47 ft.

●

The first of fifty C-130A Hercules transports, strengthened for operation with 20-ton payloads at 35,000 ft., has been redelivered to the USAF. Improvements include reskinning 30 percent of the fuselage with thicker aluminium panels, installation of a tandem rudder boost system, a redesigned electrical system and a 40-manhour oxygen system. Propeller speed was reduced by means of a gear box ratio change to decrease vibration and noise level without handicapping performance.

Production of a new small rotary-wing Gyrocopter has begun at Bensen Aircraft Corp. It is powered by a 4-cylinder 72-h.p. engine ; weight equipped is 250 lb., while take-off weight is about twice as much. It has a two-blade rotor of 20 ft. diameter; and is available as a construction kit (price without engine $395); ex works in flying condition $2,995.

●

The Rolls-Royce Conway by-pass turbojet has now been approved by the ARB at 18,000 lb. minimum dry thrust for civil operation. Deliveries of *Conway* engines to Boeing and Douglas began in October 1958 for the 707-420 and certain versions of the DC-8, at a guaranteed minimum rating of 16,500 lb. dry thrust, which is the rating offered for initial *Conways* in airline service. The ARB and FAA have already approved this engine at 17,000 lb. dry thrust. After an initial period of experience, *Conways* in airline service can be uprated to 17,500 lb. guaranteed minimum dry thrust by a minor adjustment to the external control system. Production deliveries will then be made at this rating. The approval now given by the ARB covers this second step of civil development for the *Conway,* and FAA approval will shortly be sought.

●

Conversion of two Boeing B-47 Stratojets into pilotless drone aircraft for offensive and defensive test missions is nearing completion at the Marietta, Georgia Division of Lockheed Aircraft Corporation. The first of the two Boeing B-47 drone aircraft, to be known as QB-47, is scheduled for flight testing this spring and for delivery to the USAF's Air Research and Development Command this summer. Modification work is being done by Lockheed and Sperry Gyroscope Company, the latter as designers of the guidance and control system. The QB-47 will be used to test the vulnerability and retaliatory effectiveness of the North American continent's key defence systems (DEW Line, White Alice, etc.).

●

KLM, Philips and the Rijksluchtvaartdienst are at present testing a new runway approach lighting system at Eelde Airport near Groningen. This experimental equipment, developed by Rijksluchtvaartdienst, is installed in conjunction with the already existing approach lighting system (of Dutch design, and which has been proposed as an international standard).

●

Société Latécoère placed an order early in 1957 for a test bench designed for acceleration tests on aircraft tanks. The Latécoère 777 is designed to test tanks up to 3.3 ft. in diameter, 26.3 ft. in length, and 4,410 lb. in weight when full. A maximum 6 g deceleration and 12 g acceleration effect can be obtained, with angles of ± 20° pitch and ± 15° roll.

●

The first Chance Vought F8U-2 Crusader production model was delivered to the Navy on January 28th, 1959. The F8U-2 is equipped with a Pratt & Whitney J57-P-16 engine. Armament is the same as on the earlier F8U-1 : four 20-mm cannon, two *Sidewinder* missiles and a pack of thirty-two 2.75-in. *Mighty Mouse* rockets. Prototype versions of the F8U-2, converted from F8U-1 aircraft, have already been flying for several months. Chance Vought furthermore states that the F8U-1 and F8U-1P are still in production at its Dallas plant.

●

A new all-weather F8U-2N version of the *Crusader* is also announced, and substantial quantities are to be produced for the Navy. Initial deliveries of this *Crusader* version are scheduled for early 1960. Basically the F8U-2N is a development of the F8U-2 with improved navigation aids, instrumentation and radar (a Chance Vought-developed autopilot will be fitted) ; the aircraft will also carry improved exterior lighting systems. Powerplant : one Pratt & Whitney J57-P-20, which will give the F8U-2N an even higher speed than the F8U-2 during combat. Furthermore, the 2N will have provision for utilizing, in addition to the *Sidewinders,* newer type missiles now under development.

●

The current Vanguard test programme is aimed at the completion of some 1,500 hours' flying and the award of the Certificate of Airworthiness before the first delivery to BEA, which is scheduled for spring 1960.

●

Chance Vought has announced delivery of the last *Regulus I* (Number 514) to a West Coast Navy base. *Regulus I* had been in production since 1958.

Correction : In the article on the Nord SS.11 weapon system in No. 1 (p. 56), it was erroneously stated that the missile could pierce armour plating up to 2.4 inches thick. The figure should, of course, read 24 inches. Apologies to Nord-Aviation !

Airlines that are first with the COMET
establish an enduring traffic lead
The COMET jet airliner
(Rolls-Royce Avon engines)
Earliest delivery
A known quantity
Can go everywhere
Pays its way on moderate traffic
—and with high frequency
DE HAVILLAND

EMPHASIS ON MOBILITY

Nowadays changes in strategical concept, the type of defence required, and the very nature and direction of any hostile threat, occur with bewildering rapidity. Deployments undertaken at enormous cost are found to be no longer required. Defences need re-siting. The exact location of static sites becomes common-knowledge. Formations and units in the field need defending. **TO ALL THESE PROBLEMS, THE ANSWER IS**

THE 'ENGLISH ELECTRIC' THUNDERBIRD

The ENGLISH ELECTRIC 'Thunderbird', now in production, is a completely mobile ground-to-air weapon system. Its mobility provides the flexibility which is becoming of ever increasing importance in future air defence . . . **AND THE ECONOMY AS WELL**

A MEMBER OF THE ***ENGLISH ELECTRIC*** *AVIATION GROUP*

GW21A

TWO FOR ONE

The Super Tiger is a high altitude fighter or a low-level attack bomber. The ease with which a pilot can make the transition to the Tiger series eliminates the costly need for two-seat trainers. Designed for use on aircraft carriers, the Super Tiger can operate from small hidden airstrips without the use of artificial flight augmentation.

Per maintenance hour, U. S. Navy F11F-1 Tigers have flown twice as many hours as any other type of jet aircraft presently on Naval operations. With these same maintenance-free features inherent in the higher performance Super Tiger, it is literally two aircraft for the price of one.

Grumman

GRUMMAN AIRCRAFT
ENGINEERING CORPORATION
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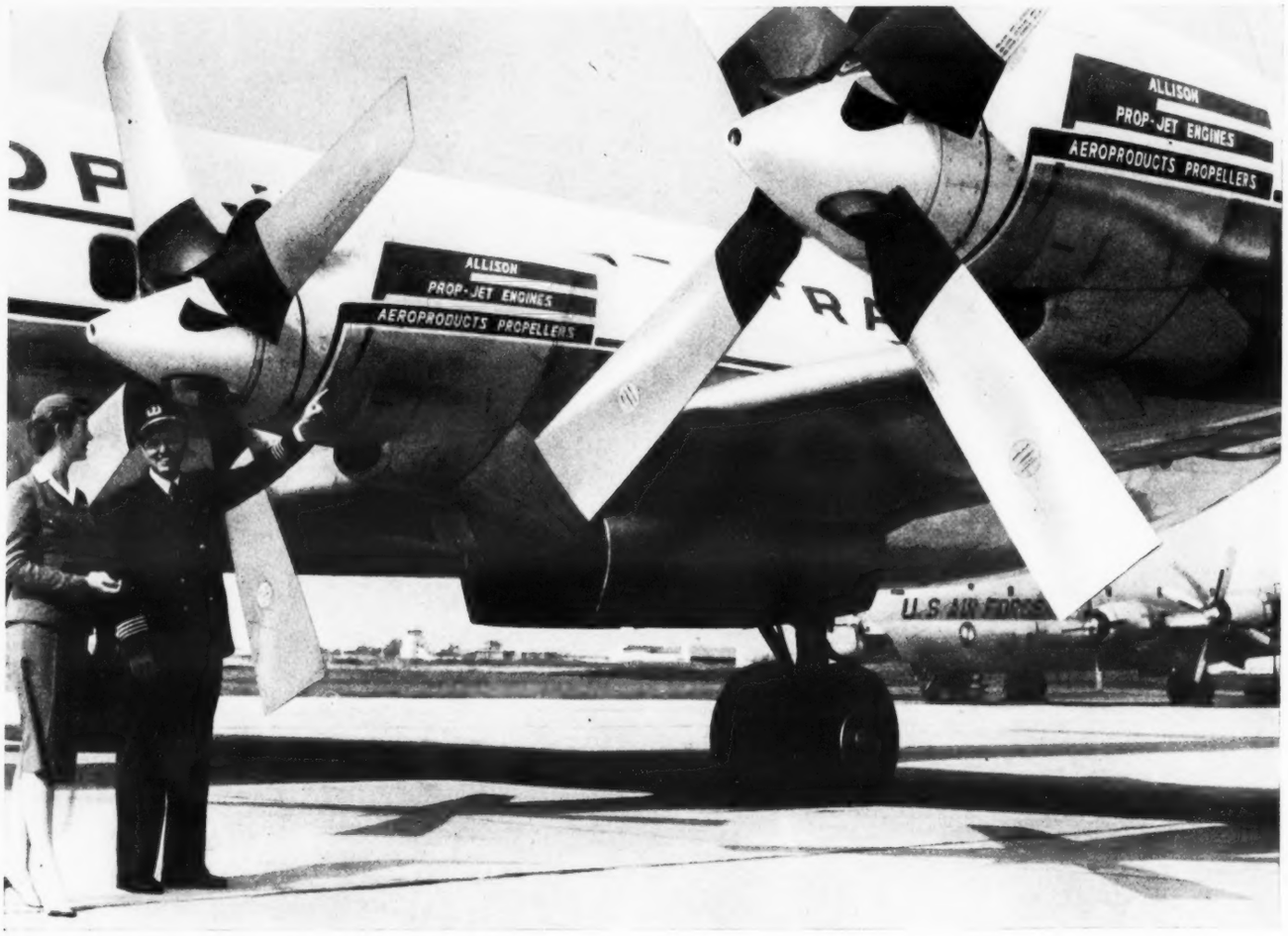
Allison Prop-Jet Engines and Aeroproducts Turbo-Propellers... Profitable Power Team for More than 75 % of all Jet-Age Transportation



The Allison-powered Lockheed Electra is now joining the jet-age fleets of 15 airlines. It has proved that, in addition to its long-range capabilities, it brings jet-age superiority with economy on short to medium ranges which make up more than 75% of all travel by air.

The greater efficiency of jet-plus-prop provides outstanding take-off, climb, cruise and landing performance. The reverse thrust produced by the Aeroproducts Turbo-Propeller assures positive stops on short, wet or icy runways. Low vibration and sound levels please the passenger as well as the airport neighbour.

The Allison Model 501 prop-jet engine, with its matched Aeroproducts Turbo-Propeller provides a GM jet-power team with performance far beyond any prop-jet powerplant now in commercial service.

ALLISON PROP-JET POWER

BACKED BY THE WORLDWIDE RESOURCES OF GENERAL MOTORS

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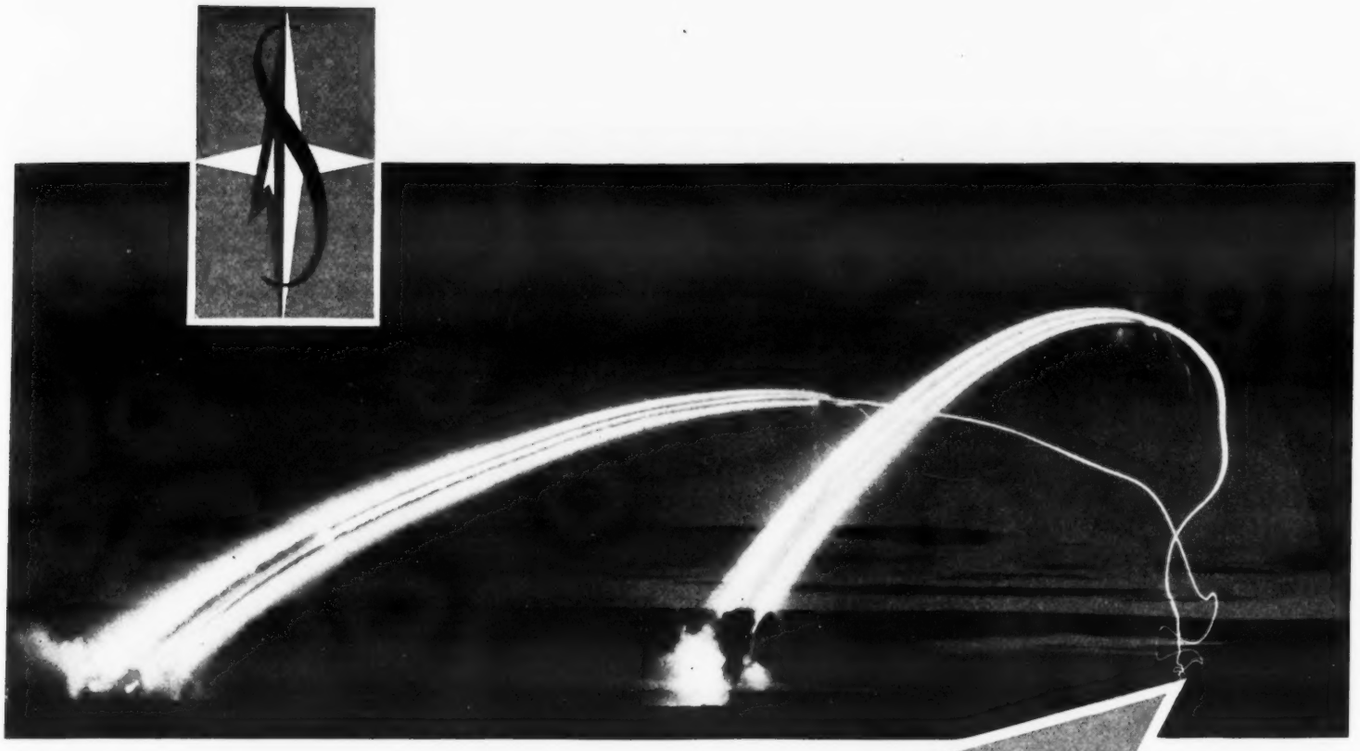

precision
through guidance

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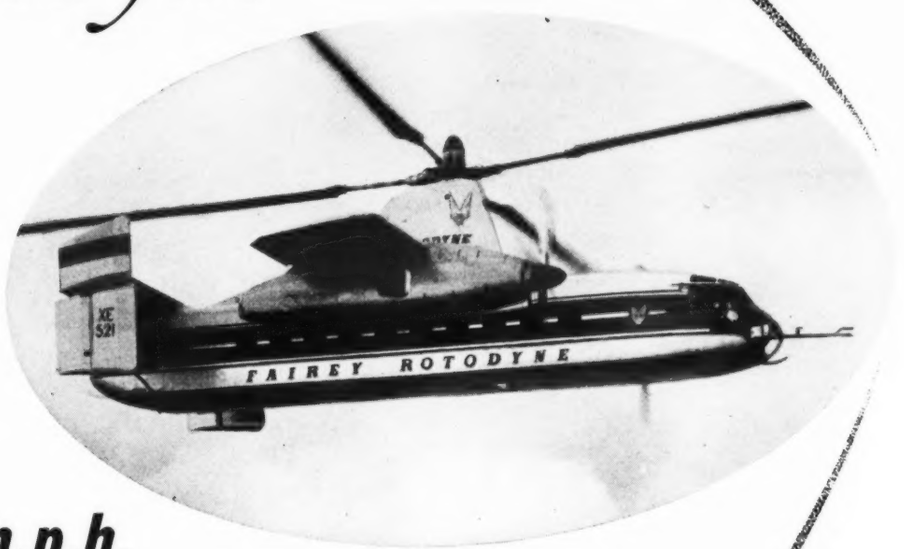
The Record Breaking Rotodyne



191 m.p.h.

Proved the world's fastest rotorcraft

Fairey's Rotodyne vertical take-off airliner has established itself as the fastest rotorcraft in the world. On 5th January, 1959, it flew round a 62 mile closed-circuit record course at an officially observed average speed of 191 m.p.h. for a new world convertiplane speed record—at *cruising* power and *operational* weight.

This record, almost 50 m.p.h. faster than the corresponding helicopter record and 30 m.p.h. faster than the absolute speed record for helicopters, confirms Fairey's claim that the true V.T.O. airliner is here, now, for city-centre to city-centre journeys, needing no expensive airfields, wasting no valuable time.

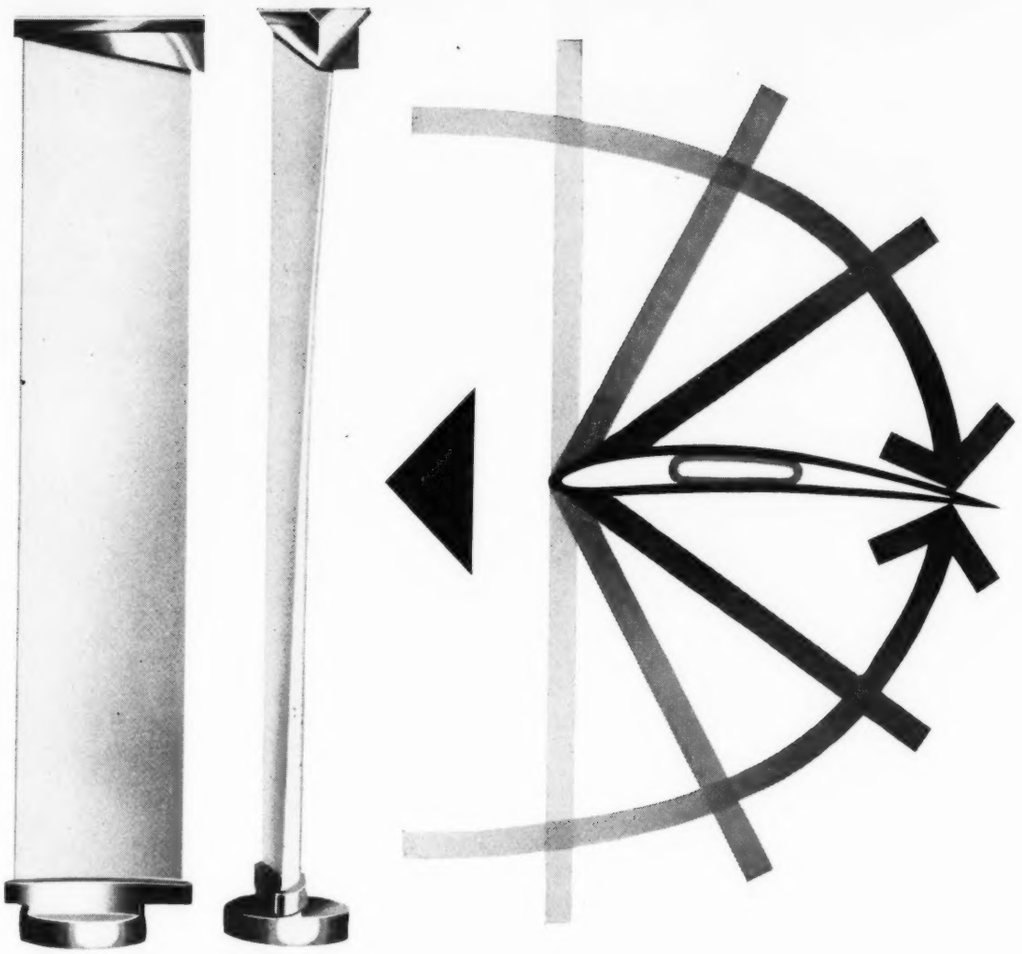
(Subject to F.A.I. Confirmation)

FAIREY *Rotodyne*

Powered by Napier Eland turbo-props

THE FAIREY AVIATION COMPANY LIMITED HAYES · MIDDLESEX

ENGLAND · AUSTRALIA · CANADA



The illustration is shown by courtesy of Armstrong Siddeley Motors Ltd.

A new way with Hollow Blades

Wilmot Breeden, interested in the manipulation of metal in the cold state, have developed in co-operation with famous jet engine firms a new process for the manufacture of inlet guide vanes and stator blades. These envelopes are now formed in nickel-chrome alloys in a succession of press operations from a flat blank, the trailing edge being brazed—in a controlled protective atmosphere—to extremely close tolerances, leaving a minimum of material to be removed and eliminating any risk of weakening the joint.

The inlet guide vanes and stator blades determine the direction of flow of the air entering and passing through the compressor to the combustion chambers. Accuracy of the envelope is vital, particularly so at the trailing edge. The vane is anti-iced by passing hot air through it. This air is distributed by means of one or more perforated ducts, which may form strengthening members, positioned within the envelope. The benefits of this process are: minimum weight for given envelope size, full response to aerofoil requirements, maximum heat transfer because of uniform wall thickness, ease of accommodating end fixings of widely differing design.

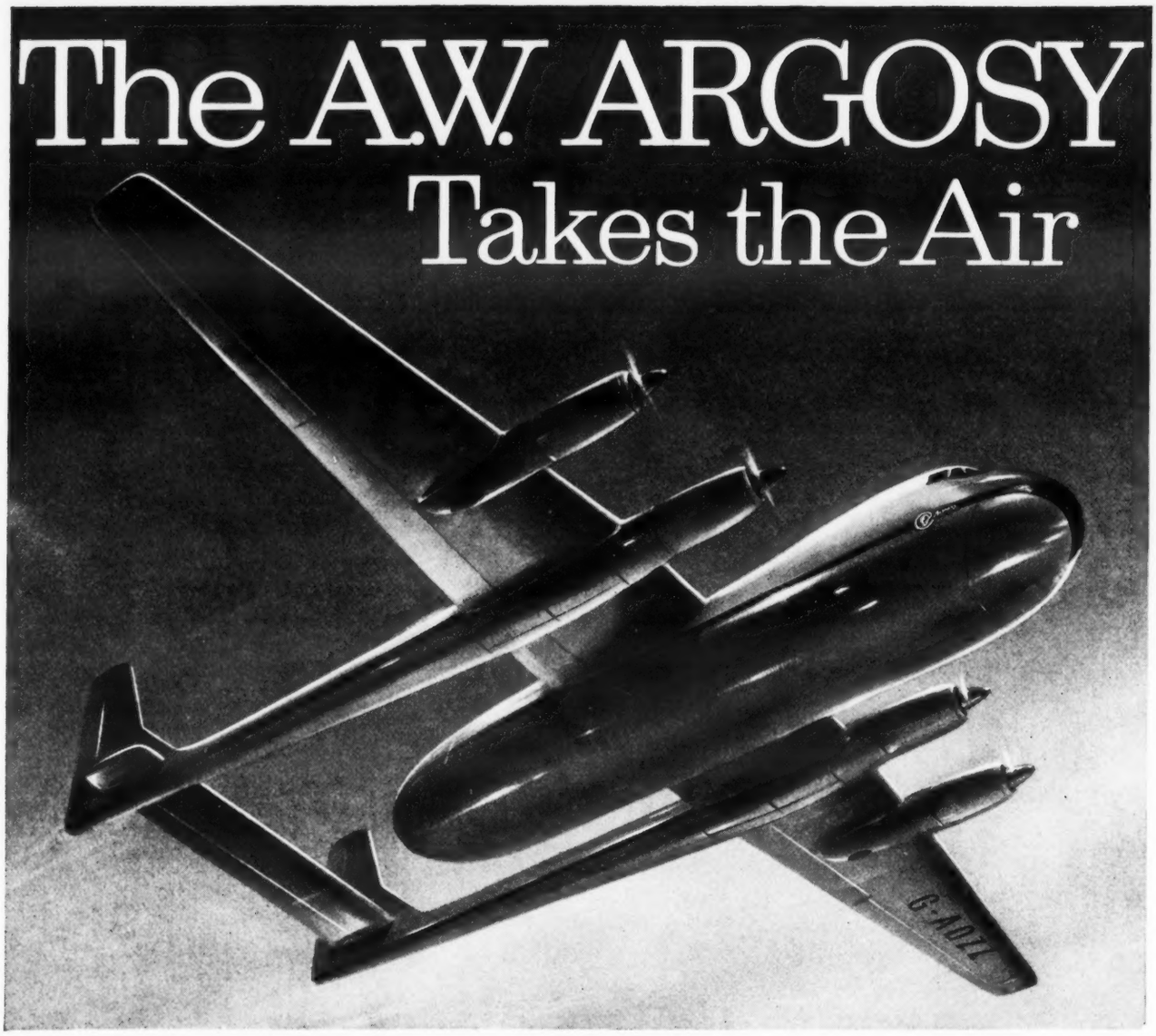
The illustration shows an inlet guide vane for a Sapphire engine; the envelope and the single air duct of this blade are of stainless steel as are the spherical end bearing and the dovetail at the root end. Both end fixings are machined and ground to close tolerances after being brazed into position by induction heating.

If you have an application for this new method we should be pleased to investigate and advise.

Wilmot Breeden are skilled in metal manipulation

Wilmot Breeden Ltd., Birmingham 1, England

The A.W. ARGOSY Takes the Air



HAWKER SIDDELEY BREAKS PRODUCTION RECORDS WITH NEW AIR FREIGHTERCOACH, FROM "GO AHEAD" TO FIRST FLIGHT IN 28 MONTHS

The Armstrong Whitworth Argosy is the world's first pressurised turboprop freighter-coach. Never before in Britain has such a large and complex aircraft made its first flight so soon after the decision to go ahead —only 28 months. This is further proof of Hawker Siddeley's unrivalled reputation in the British aircraft industry, not only for high quality craftsmanship, but ability to meet and beat production schedules. The Argosy ushers in a new era of "flying without frills". It offers 300 m.p.h. economical air transport for freight and coach-class passengers. With its capacity for 13½ short tons, full-width doors and quick-loading system, it reduces turn-around time and freight rates to a minimum. The Argosy can be in service on the world's air routes by 1960.

SIR W. G. ARMSTRONG WHITWORTH AIRCRAFT LTD.

Baginton, Coventry, England / Member of Hawker Siddeley Aviation Division

THE ***Argosy*** . . . BRINGS THE COST OF AIR FREIGHT DOWN TO EARTH

U.S. Aviation Stocks, Capital, Dividends, Prices, etc.

This time the list of companies has had to be considerably lengthened, compared with earlier years. Firms from the most varied production fields are joining the aircraft and accessories industry in increasing numbers. To cite only a few examples: Chrysler is now engaged in missile production (*Jupiter* IRBM); Ford Motor Company formed the Aeronutronics System Inc. in 1956 and is now playing an important part in the production of missile systems and equipment; General Tire & Rubber has secured a leading position in the liquid and solid propellant rocket field through its Aerojet-General subsidiary. Last but not least, the Thompson Ramo Wooldridge Corporation was formed on October 31st, 1958 by the merger of Thompson Products Inc. and Ramo-Wooldridge Corporation, whose Space Technology Laboratory exercises control over the whole USAF missile programme.

The practice of subdividing companies into manufacturers of aircraft, electronics and other equipment had to be abandoned last year already, as there are too many firms who are active in a wide variety of fields. Even the listings in the column headed "Production" were necessarily incomplete, as there just was no room to include all items. For the same reason the headings "atomic industry" and "airships" have had to be omitted this year. The new figures denoting the main activities of the individual companies are as follows:

① Aircraft and aircraft accessories
② Helicopters
③ Missiles and accessories
④ Powerplant and accessories
⑤ Electrical and electronic equipment
⑥ Other airborne and ground equipment, and factory equipment
⑦ Arms, ammunition, explosives, fuels

Company	Production	No. of shares and par value	Dividends in $ 1957	Dividends in $ 1958	Prices Feb.17,59	High 1958	Low 1958	Profit per share in $ 1957	Profit per share in $ 1958	Short-term liabilities in million $	Realizable assets in million $	Liquid assets in million $
Aircraft, Missiles and Equipment Industry												
American Machine & Foundry	⑥	3 266 217 ($ 7)	1.30	1.70	60 7/8	59 3/4	32 1/4	3.51	2.90[e]	36.6	123	15.6
American Bosch Arma	④⑤⑦	1 868 699 ($ 2)	1.05	1.20	32 3/8	37 3/8	19 3/8	2.67	.	38.4	55.8	4.29
Avco Manufacturing	③	9 405 454 ($ 3)	0.10	0.40	12 1/8	13 7/8	5 5/8	0.70	1.00	60.3	128	14.9
Beech Aircraft	①	823 352 ($ 1)	1.17	1.60	32 3/8	30 3/4	18	4.09	4.03	18.3	38.4	8.34
Bell Aircraft	①②③	2 690 101 ($ 1)	1.00	0.80	20 1/8	23 3/4	14 7/8	1.62	1.65[e]	51.1	71.7	8.61
Bendix Aviation	③⑤⑥	5 058 662 ($ 5)	2.40	2.40	71 7/8	74 1/2	44 1/2	5.44	4.18	105	238	22.3
Boeing Airplane	①③	7 319 943 ($ 5)	1.00	1.00	40 1/8	58 1/8	34 1/8	5.49	5.25[e]	312	409	45.1
Burroughs	⑤⑥	6 607 213 ($ 5)	1.00	1.00	37 3/4	43 3/8	27 5/8	1.67	1.15[e]	89.2	181	14.0
Cessna Aircraft[a]	①	1 053 903 ($ 1)	1.27	1.45	44 1/4	49	21 1/4	4.58	5.62	[f]		
Chance Vought Aircraft	①③	1 167 990 ($ 1)	1.60	1.90	38	55 3/4	31 5/8	5.65	7.45[e]	45.3	80.4	13.8
Chrysler	③	8 725 764 ($ 25)	4.00	1.50	53 3/4	59 1/8	44	13.75	def.[e]	318	667	230
Collins Radio[c]	⑤	1 504 000 ($ 1)	0.35	—	22 3/4	23	11 1/8	1.29	0.56	33.9	59.7	5.76
Curtiss-Wright	④	7 656 789 ($ 1)	3.00	2.50	29 7/8	31 1/2	20 5/8	5.07	2.60[e]	106	229	43.3
Douglas Aircraft	①③	3 816 860 (no)	4.00	2.50	50 1/2	74 7/8	54 1/2	8.28	4.41	170	358	48.9
Fairchild Engine & Airplane	①③	3 038 258 ($ 1)	—	—	10 1/4	13 1/4	7	0.17	.	38.7	58.9	7.39
Firestone Tire & Rubber	③	8 593 000 ($ 6.25)	2.60	2.60	135 1/4	136	82 3/4	7.32	6.24	128	488	45.7
Food Machinery & Chemical	③⑥	6 794 000 ($ 10)	1.00	1.05	42 3/8	46 1/4	23 3/4	2.30	2.40[e]	40.4	145	30.3
Ford Motor	③⑤	54 663 000 ($ 5)	2.40	2.00	53 3/8	50 3/4	37 3/8	5.19	1.50[e]	414	842	229
Garrett	⑥	1 033 953 ($ 2)	2.00	2.00	38 3/4	45 1/2	27	5.02	3.98	49.8	74.8	7.42
General Dynamics	①③⑥	9 842 191 ($ 1)	2.00	2.00	59 1/2	67 3/8	55	4.80	4.00[e]	300	436	53.9
General Electric	④⑤⑦	87 594 473 ($ 5)	2.00	2.00	77 1/2	79 3/8	57	2.84	2.60[e]	709	1327	257
General Motors	④⑤⑥	279 692 788 (1.66 2/3)	2.00	2.00	45 3/4	52	33 3/4	2.98	2.10[e]	978	2859	857
General Precision Equipment	⑤⑥	1 125 810 ($ 1)	2.40	0.85	35	41	27	3.03	.	47.2	100	13.2
General Tire & Rubber	③④⑤	4 826 156 (0.83 1/3)	0.67 1/2	0.70	52 1/8	50 1/4	22 1/4	2.12	1.75[e]	70	149	10.2
Goodyear Tire & Rubber	⑥	10 809 106 ($ 5)	2.40	2.40	123 3/8	124 3/4	69	6.12	5.70[e]	125	571	46.8
Grumman Aircr. Engineering	①③	2 200 000 ($ 1)	1.75	1.12 1/2	23 3/4	26 3/4	17 3/8	2.38	0.80[e]	32.3	69.6	5.24
International Business Machines	⑤⑥	12 138 000 ($ 5)	2.30	2.60	501 1/2	552	300	7.73	10.65	112	490	292
Internat, Telephone & Telegraph[a]	⑤	7 176 677 (no)	1.80	0.90	63 5/8	32 3/4	14 5/8	1.56	1.75[e]	231	432	34.6
Lear Inc.[b]	③⑤⑥	2 368 000 ($ 0.50)	0.30	0.10	11 1/8	10 1/4	4 1/4	0.36	.	17.2	29.5	4.40
Lockheed Aircraft[a]	①③	6 299 626 ($ 1)	2.40	1.20	29 1/4	34 1/2	19 1/8	2.76	3.00[e]	238	344	34.9
Martin Co	①③	2 923 665 ($ 1)	1.60	1.60	37 1/8	36 7/8	30	3.38	3.75[e]	93.1	110	14.1
McDonnell Aircraft[b]	①③	1 647 981 ($ 5)	0.50	1.00	36 3/8	36 3/4	22 1/2	6.34	6.33	95.3	121	1.83
Minneapolis Honeywell Regul.	④⑥	6 985 333 ($ 1.50)	1.75	1.75	117 1/4	126	76	3.07	3.25[e]	38.6	169	11.8
North American Aviation	①③④	8 015 077 ($ 1)	2.00	1.60	40 5/8	45 7/8	25 5/8	4.23	3.34	127	258	38.1
Northrop Aircraft	①③⑤	1 583 173 ($ 1)	1.60	1.60	34 1/4	37 1/2	22 1/8	3.62	4.29	50.9	73.2	10.7
Olin Mathieson Chemical	⑦	13 282 121 ($ 5)	2.00	1.50	44 7/8	45 1/8	31 1/2	2.67	1.05[e]	84.0	336	96.4
Philco Corp.	③⑤	3 989 833 ($ 3)	4 %st.	2 %st.	24 7/8	26 3/8	12 3/8	1.00	.	70.6	150	26.0
Piper Aircraft	①	927 221 ($ 1)	1.00	1.00	25 3/4	24 1/2	14	2.94	2.36	4.01	10.4	2.06
Radio Corp. of America	⑤	13 843 000 (no)	1.50	1.50	46 7/8	48 1/4	30 1/4	2.52	2.00[e]	166	472	106
Republic Aviation	①③	1 472 013 ($ 1)	2.00	2.00	26 1/4	29 1/2	16 1/2	4.15	3.50[e]	27.8	62.7	21.1
Rohr Aircraft[a]	①	1 770 000 ($ 1)	0.93	0.93	22	37 1/2	15	2.76	2.85	54.0	70.6	2.35
Sperry-Rand	③⑤⑥	28 279 311 (0.50)	0.80	0.80	21 5/8	25 3/8	17 1/4	0.96	1.15[e]	178	496	44.9
Sylvania Electric Prod.	③⑤	3 532 012 ($ 7.50)	2.00	2.00	61 3/4	61 1/2	31 1/2	3.48	2.50[e]	47.3	172	4.58
Temco Aircraft	①③	1 699 113 ($ 1)	0.75	0.75	16 1/8	20 3/8	9 3/4	1.50	1.55[e]	31.8	44.9	4.69
Texas Instruments	⑤	3 257 000 ($ 1)	—	—	74 3/8	86	26 3/4	1.11	.	[g]		
Thiokol Chemical	④⑦	1 368 000 ($ 1)	5%st.	5 %st.	105 1/2	102	37 1/2	1.48	.	14.6	17.4	1.28
Thompson Ramo-Wooldridge	③⑤	3 025 015 ($ 5)	1.40	1.40	59 7/8	73	41 3/8	4.20	2.75[e]	33.3	92.2	8.68
United Aircraft	②④⑥	6 363 404 ($ 5)	2.63	3.00	59 3/8	69 7/8	52 1/2	7.97	6.50[e]	176	312	57.0
Vertol Aircraft[c]	②	661 000 ($ 1)	10%st.	5 %st.	18 1/2	23 3/4	12 1/2	2.78	.	13.4	22.3	3.38
Westinghouse Electric	④⑤⑥	17 180 000 ($ 12.50)	2.00	2.00	75	74 1/2	55 1/2	4.18	4.25	236	942	236
Air Transport Industry												
American Airlines		7 951 487 ($ 1)	1.00	1.00	28 3/4	25 3/4	14 3/8	1.31	.	74.9	110	65.9
Braniff Airways		2 948 119 ($ 2.50)	0.60	0.60	13 1/2	12 3/8	6 7/8	0.59	0.98	10.5	19.5	7.76
Capital Airlines		909 559 ($ 1)	—	—	21 3/4	19 7/8	10 3/8	3.16[d]	.	17.7	19.4	5.48
Eastern Air Lines		2 987 764 ($ 1)	1.00 + 2 %st.	1.00 + 2 %st.	38 3/4	38 1/8	29 1/8	3.21	2.31	39.3	74.4	17.6
Flying Tiger Line[b]		1 032 817 ($ 1)	5 %st.	5 %st.	12 7/8	12 3/8	6 1/4	0.67[d]	0.43	7.94	11.3	2.80
KLM		1 429 540 (Fl. 100)	0.79	1.05	31 1/2	29 3/4	25 1/4	3.98	.	32.1	60.0	29.9
National Airlines		1 158 822 ($ 1)	1.00	12 1/2 %st.	26	22 3/4	12 7/8	2.73	0.54[d]	9.99	11.6	3.82
Northwest Airlines		1 374 000 ($ 10)	0.80	0.80	37 1/4	33 1/8	10 1/8	3.56	3.98	15.6	21.9	8.48
Pan American World Airways		6 552 913 ($ 1)	0.80	0.80	28 1/4	23 1/2	12 3/4	1.35	1.15[e]	79.4	86.9	25.8
Seaboard & Western[b]		998 000 ($ 1)	4 %st.	—	10 3/4	13 1/4	5 3/4	0.40[d]	.	6.78	3.91	0.27
Trans World Airlines		6 674 000 ($ 5)	—	—	17 1/2	17 3/8	10 1/2	0.23[d]	.	66.2	79.9	19.9
United Air Lines		3 675 000 ($ 10)	0.50	0.50	34 7/8	33 5/8	21 1/4	2.28	.	64.6	82.4	29.6

[a] = Changes in capital (stock splits, stock dividends, etc.). In February 1959 International Telephone & Telegraph and Lockheed both offered their shareholders two new shares for one old one, in December 1958 Rohr Aircraft split its stock in the ratio of two new for three old. Cessna distributed a 10% stock dividend in December.

[b] = Stocks trading on the American Stock Exchange; companies not so indicated trade on the New York Stock Exchange.

[c] = Over the counter.

st. = Stock dividend

[d] = deficit

[e] = estimated

[f] = Cessna acquired Aircraft Radio Corp.

[g] = Merger proposed with Metals & Controls Corp.

INTERNATIONAL MEETINGS AND CONFERENCES

March 5th : Deutscher Helicopter-Dienst, Rietdorf KG — helicopter conference. Kretz/Andernach.

March 5th : RAeS — First Fairey Memorial Lecture, " Sir Richard Fairey — an Appreciation," by G. W. Hall. London Airport.

March 5th-7th : Western Space Age Conference and Exhibit. Los Angeles, Calif.

March 6th : Helicopter Association — "The Place of the Helicopter in a Modern Army, " by Lt.-Col. P. W. Mead. London.

March 7th : British Interplanetary Society — " Radio Communications with a Space Probe," by Dr. W. T. Blackband. London.

March 8th-11th : Engineering Meeting on the Turbine in Action, sponsored by the Gas Turbine Division of the American Society of Mechanical Engineers. Cincinnati, Ohio.

March 9th : ICAO European Civil Aviation Conference, Third Session. Strasbourg.

March 9th-12th : American Society of Mechanical Engineers, Aviation Division Conference. Los Angeles, Calif.

March 10th-17th : 14th Conference of the International Federation of Air Line Pilots' Associations. Helsinki.

March 11th : Aircraft Industries Association, Export Committee Meeting. Arlington, Va.

March 12th : RAeS : 12th Louis Blériot Lecture, " The Nord Griffon ; and Turboramjet Power, " by Noël Daum. London.

March 12th-13th : Canadian Aircraft Industry Symposium, sponsored by the Toronto Section, Instrument Society of America. Toronto.

March 19th : RAeS Guided Flight Section: " Long Range Missiles," by E. C. Cornford. London.

March 19th-20th : Flight Propulsion Meeting, sponsored by IAS. Cleveland, Ohio.

March 20th : IATA Universal Postal Union Contract Committee. The Hague.

March 23rd-25th : ARS Spring Meeting and Flight Testing Conference. Daytona Beach, Fla.

March 23rd-26th : National Convention, Institute of Radio Engineers. New York.

March 25th : Lubrication Group of IME, discussion : " Problems of Lubrication at High Temperatures ". London.

March 31st-April 2nd : Brooklyn Polytechnic Institute — 9th International Symposium : " Millimeter Waves ". Co-sponsored by the Department of Defense Research Agencies and Institute of Radio Engineers. New York.

March 31st-April 3rd : National Aeronautic Meeting, Society of Automotive Engineers. New York.

April : IATA Taxation Sub-Committee. Montreal.

April 1st-28th : 3rd World Meteorological Congress. Geneva.

April 5th-10th : 5th Nuclear Congress of Engineers, Joint Council. Cleveland, Ohio.

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New York Finance Notes

Are Airline Stocks a Good Buy ?

BY SCOTT HERSHEY, NEW YORK

The market school of thought which stresses cyclicals has led many Wall Street analysts to favor transportation stocks—automobiles, rails and airlines. Although many railroad and airline stocks have moved from their lows of early 1958 they still lag behind the market. That is largely because they were not big gainers in the latter stages of the 1953-1957 boom.

Airline stocks look good to a number of analysts who think the advent of jet passenger flight will mean increased earnings and new investor interest. Mentioned most frequently in this regard are American, Eastern, United and Pan American.

However, narrowing margins between income and outgo threaten airline investors with the fate of railroal investors—the necessity of putting vast sums into capital improvements but with little prospect that the investments will raise profits. At the moment, the airlines' outlook in this regard is even worse than the railroads in the opinion of some analysts.

Several hundred jet airplanes costing upwards of $6,000,000 each must be bought almost immediately. Where the railroads have deferred new equipment into use at the expense of losing patronage, the airline cannot do this. For one reason, much of their mileage is overseas, in direct visible competition with other nations' government-owned lines. And in the second place, the U.S. civil air fleet is looked upon as an auxiliary to the fighting force in time of trouble, and the two cannot be maintained on widely disparate standards.

Most of the troubles of the airlines in the past have been cured by a rise in traffic. In 1958 the end of this happy situation came into view. While passenger miles set their customary new highs, the increase over 1957 was only two percent. Since World War II, each year's gain has been between 13 and 18 percent. Some of the drop in the rate of increase can, of course, be attributed to the strikes which plagued the industry, but there appears to be little doubt that air travel is no longer rising as sharply as in the past.

On the bright side is the fact that 1958 moved the airline industry into the jet age, and the introduction of jet commercial operation is bound to have a tremendous impact on the economic future of the airline industry. On the basis of the introductory period, the future of jets appears as promising as the industry predicted. Immediate passenger reception and relative freedom from the basic maintenance difficulties sometimes prevalent in new planes are prime reasons for the operators' optimism.

And the day of the piston-powered airliner is far from done. Passengers unable to get reservations on the jets are taking other flights, and a part of the jet traffic is to destinations other than jet terminals, meaning that part of the journey will be in piston-powered planes.

The final impact of jets on the airline profit and loss statements is yet to be determined, because of the newness of their operations, but it will provide most interesting watching for holders of airline securities.

Despite record revenues, net profits of the nation's 12 trunk lines totaled only $30 million for 1958, up about $3 million over 1957, but only half the earnings of 1956. The 11 percent increase over the depressed 1957 level did help spark a rebound in stock prices ranging from 60 to 90 percent, and shares of major lines closed the year at or near their highs.

In addition to the aforementioned American, Eastern, United and Pan American which are liked by some Wall Streeters, there are some others which are attracting attention. These include Delta, whose director recently voted to resume payments of dividends on common stock with a declaration of 30 cents a share for distribution on March 2nd. Most recent payment was a similar amount, distributed March 3rd, 1958, prior to which 30 cents a quarter was distributed in 1957.

In the more speculative group might be mentioned Capital whose recent price has been around $18^3/_4$ and Continental Airlines which has been around $6^3/_4$. Airline equities would not generally be sought out by the more conservative investor, perhaps, but they do have considerable attraction for others since, as mentioned before, they have not, with the exception of Pan American, shared in the forward motion of the market in recent months.

But the air transport industry has many factors indicating a rise in earning power within the next few years, and a strong growth element certainly exists. Once that potential is translated into earnings, airline securities will begin to take their place in the rising market.

A situation which will be watched with interest is the possibility that American Airlines may be in the market soon, perhaps by the time this reaches print, with an equity type offering. William J. Hogan, Executive Vice President—Finance told the Controllers Institute of America that " prudence dictates the desirability of a strong cash position and an adequate equity base. It may be therefore that if the security market continues on the strong side we would take advantage of the situation and obtain some additional financing, despite the fact that our entire equipment program is already financed."

American's most recent public financing was in June of 1946 when it sold $40,000,000 in preferred stock and $40,000,000 of convertibles debentures. The most recent private financing was arranged in September of 1956 when American obtained a $60,000,000 loan of which $30,000,000 was from the Metropolitan Life Insurance Company and a like amount from The Prudential Insurance Company of America. Hogan said that American expected to finance about $200,000,000 of the cost of converting its system to jet equipment out of cash on hand, cash flow from depreciation allowances, retained earnings and sales of piston equipment. He noted that the market for used piston equipment cannot be counted on as a major source of funds.

American has just announced in this connection that it would convert ten of its DC-7B passenger planes to cargo aircraft. By turning a number of these piston planes into freighters, American not only will take some of the pressure off the used-plane field, but also will provide itself with first class cargo aircraft. Douglas will do the job.

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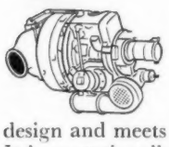

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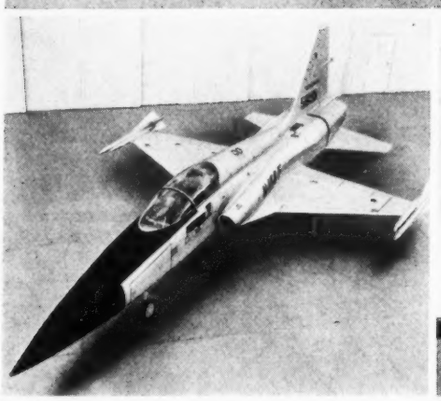

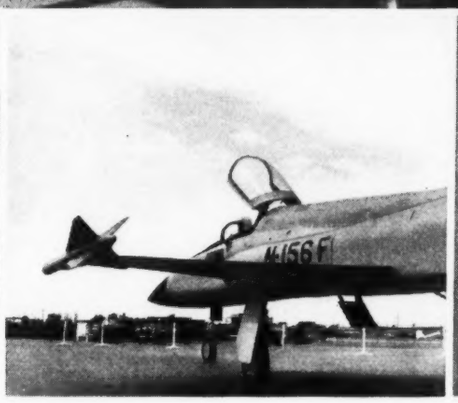

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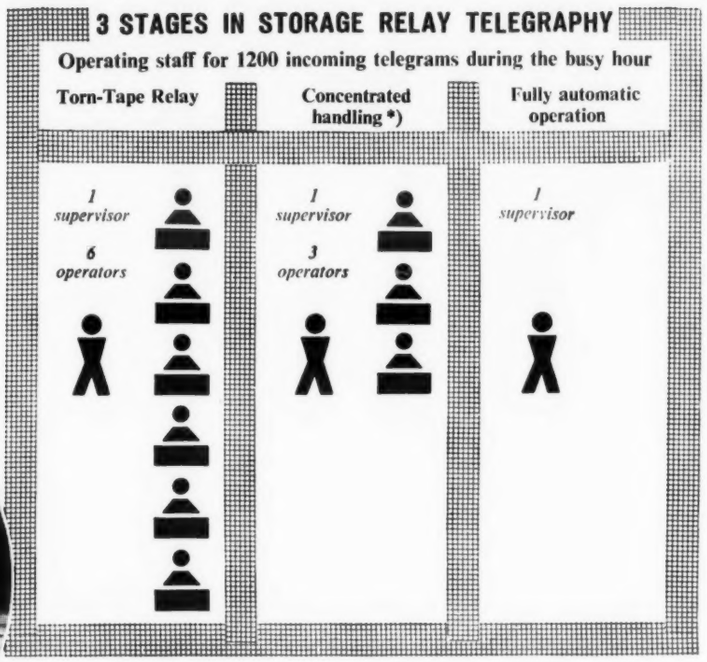

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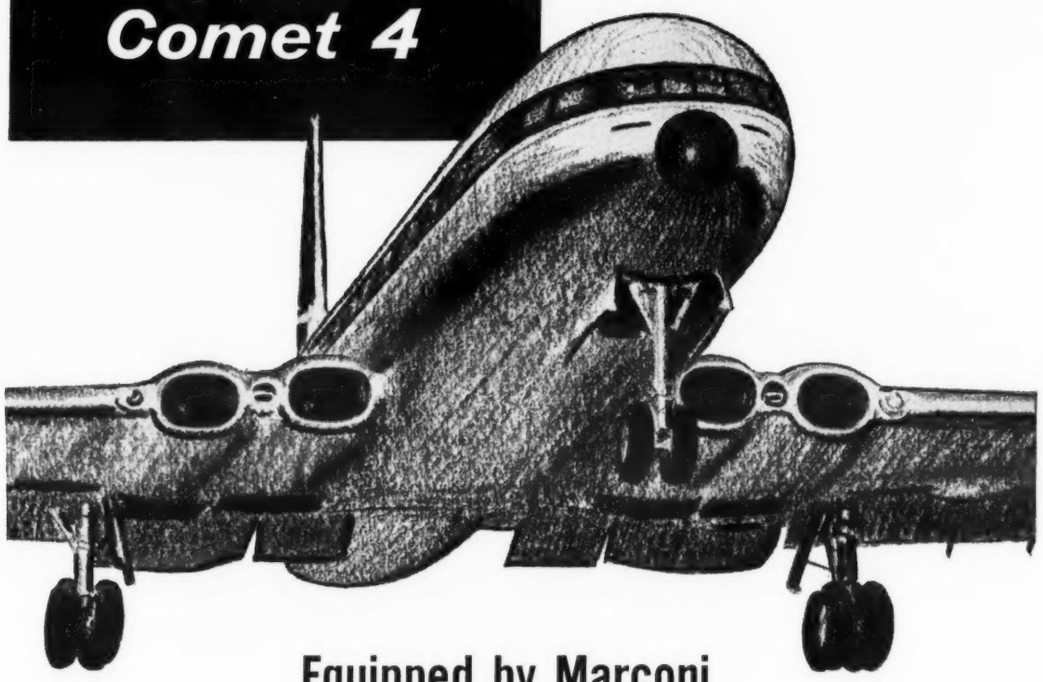

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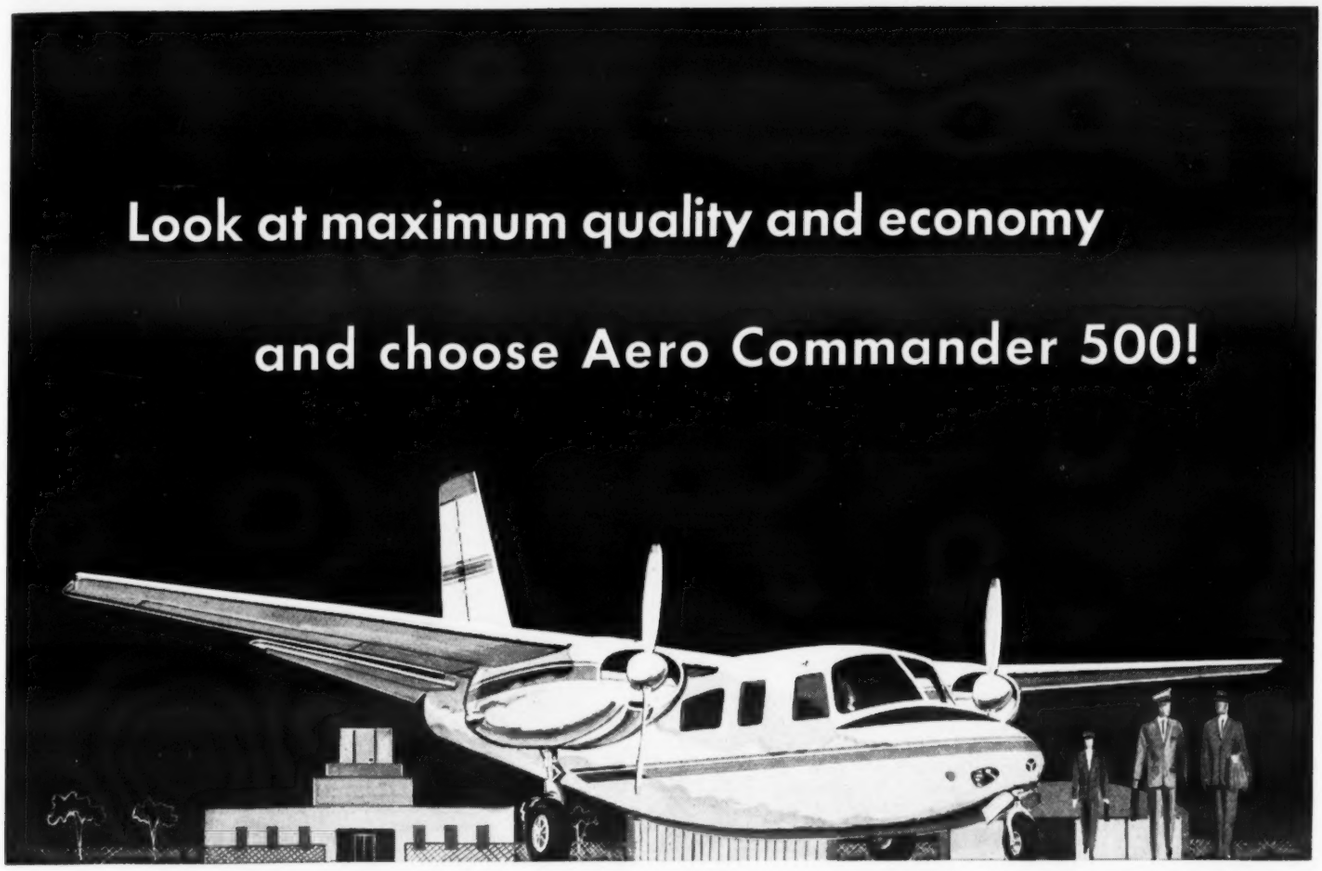

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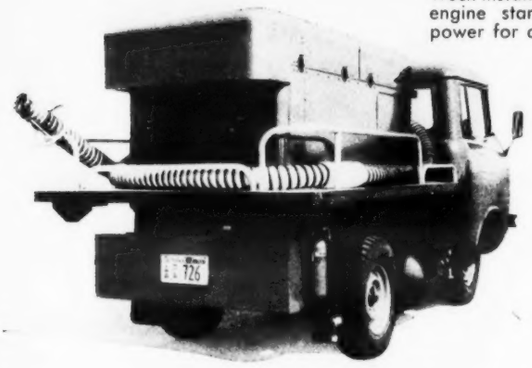
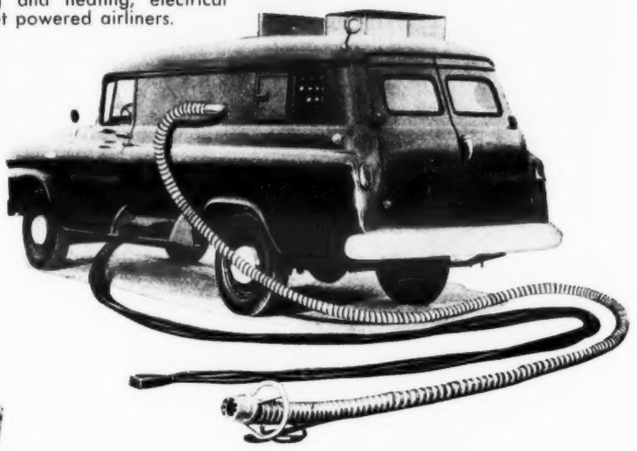
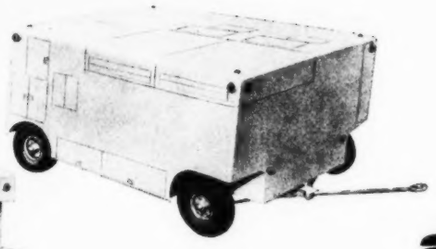
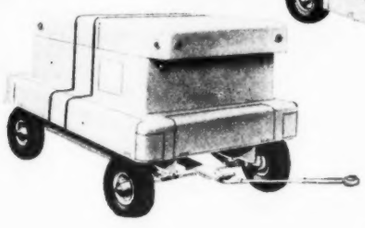




Dual carts for main engine starting, air conditioning and electrical power for military aircraft.





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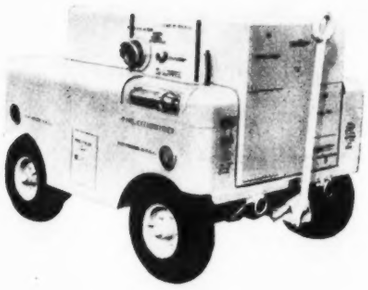
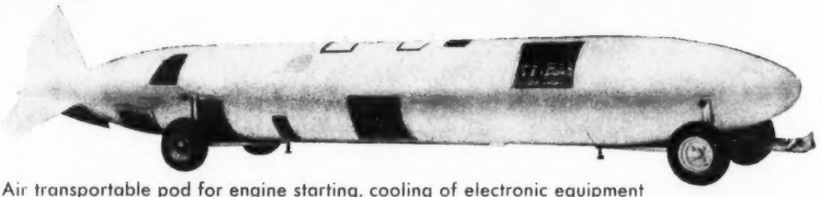
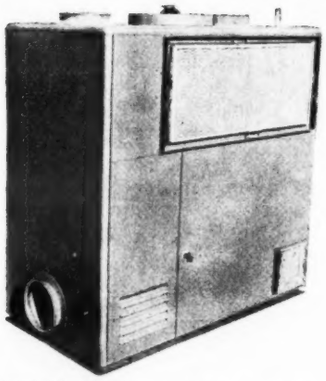




Air transportable pod for engine starting, cooling of electronic equipment and pre-flight checkout for military aircraft.



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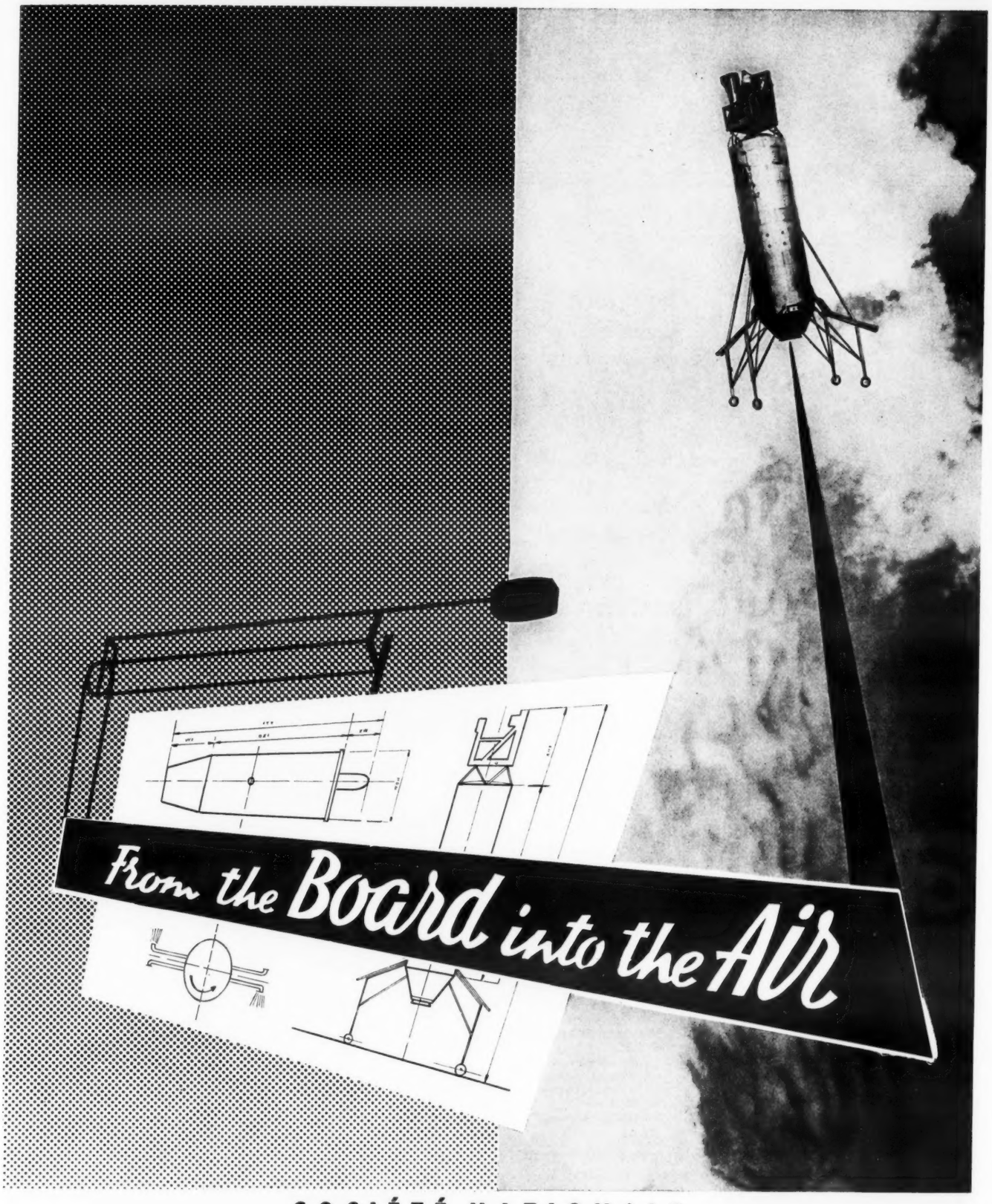

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Chief of Structures, N.V. Koninklijke Nederlandse
Vliegtuigenfabriek Fokker, Holland.

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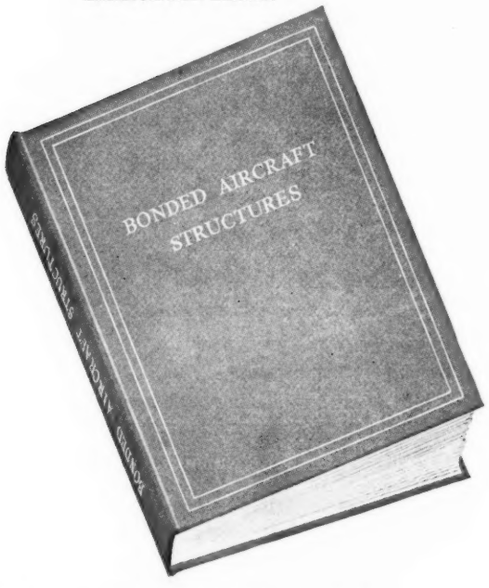

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Head of Process Development,
A. V. Roe & Co. Ltd.

BONDING OF AIRCRAFT MAGNESIUM ASSEMBLIES WITH 'REDUX' ADHESIVE
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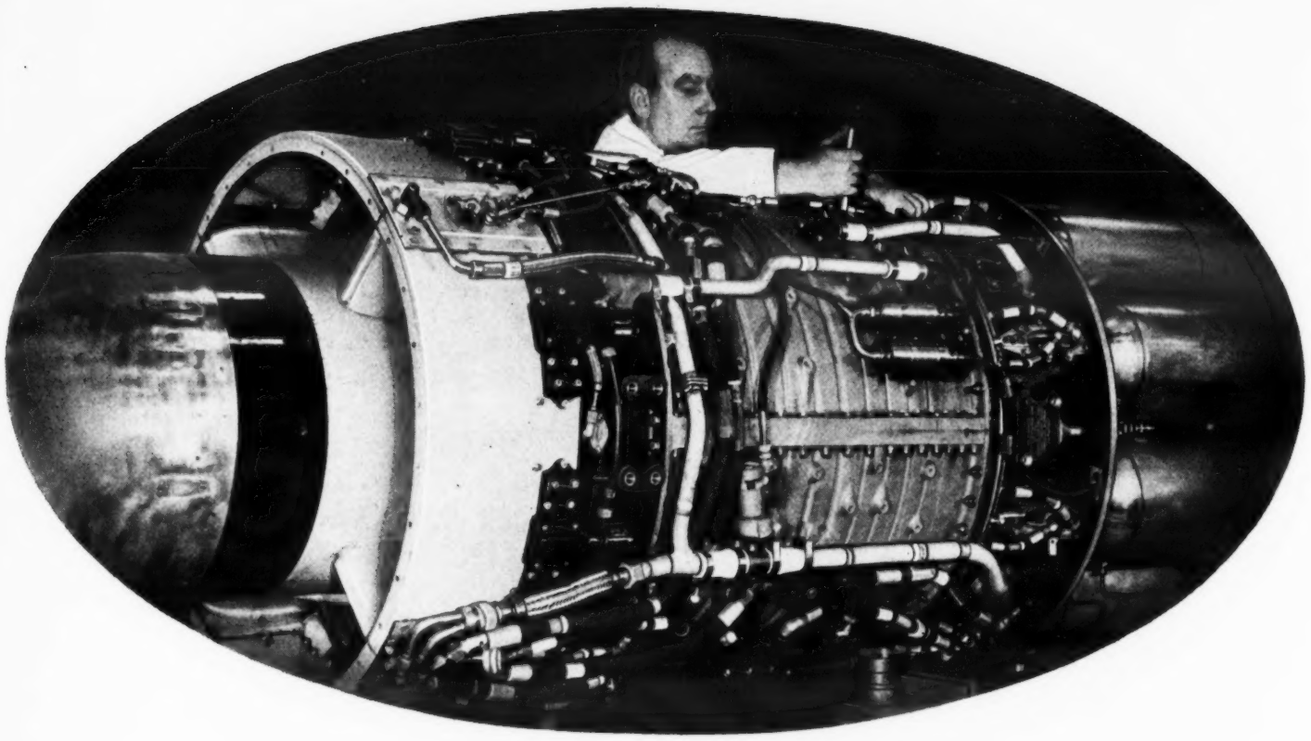

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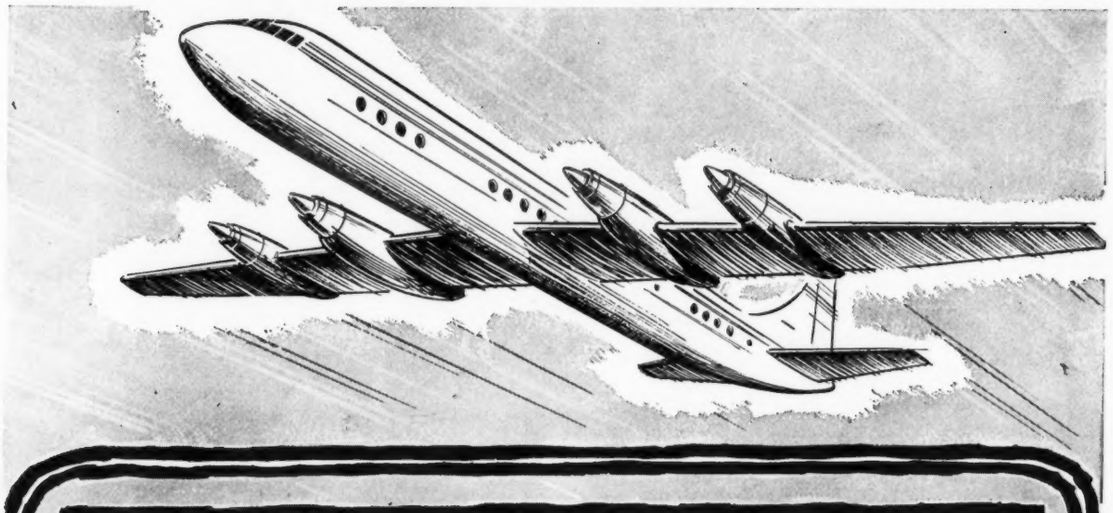

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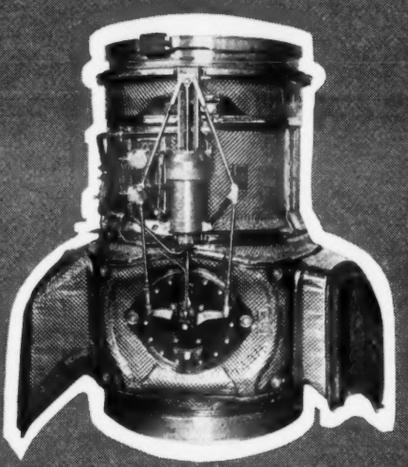

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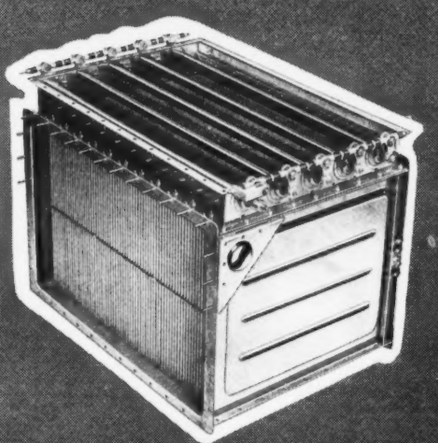
These thermal blankets are made of refractory fibre cased in .004 inch (.1016 mm) stainless steel. They are made-to-measure and are extremely light, the dimpled construction being responsible for their great strength. Specified for Rolls-Royce and Armstrong Siddeley jet and turbo-prop engines, these particular examples are shown fitted to the Rolls-Royce thrust reverser for the de Havilland Comet.



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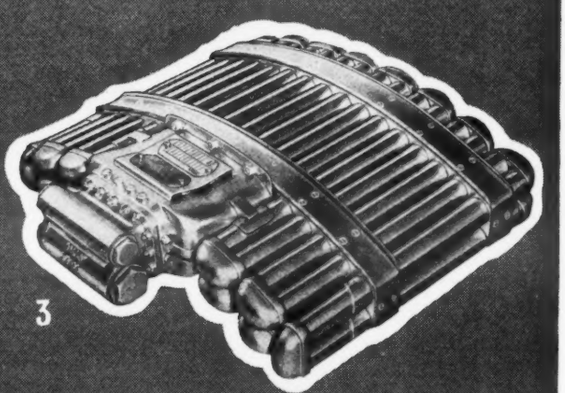

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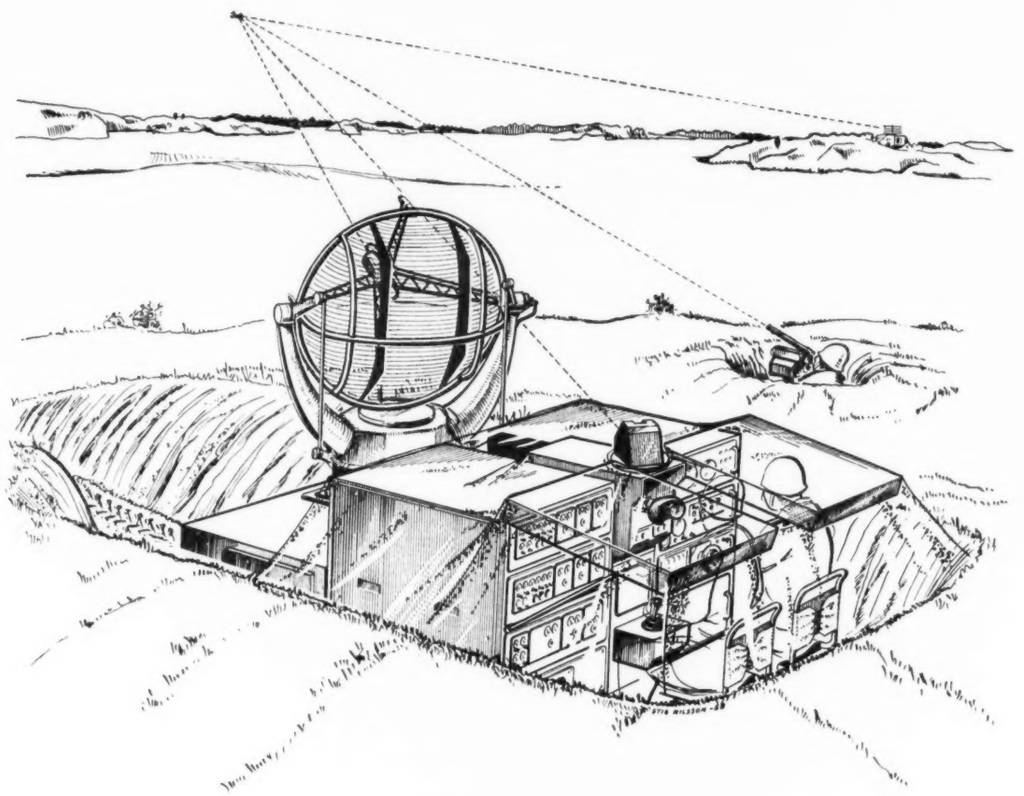

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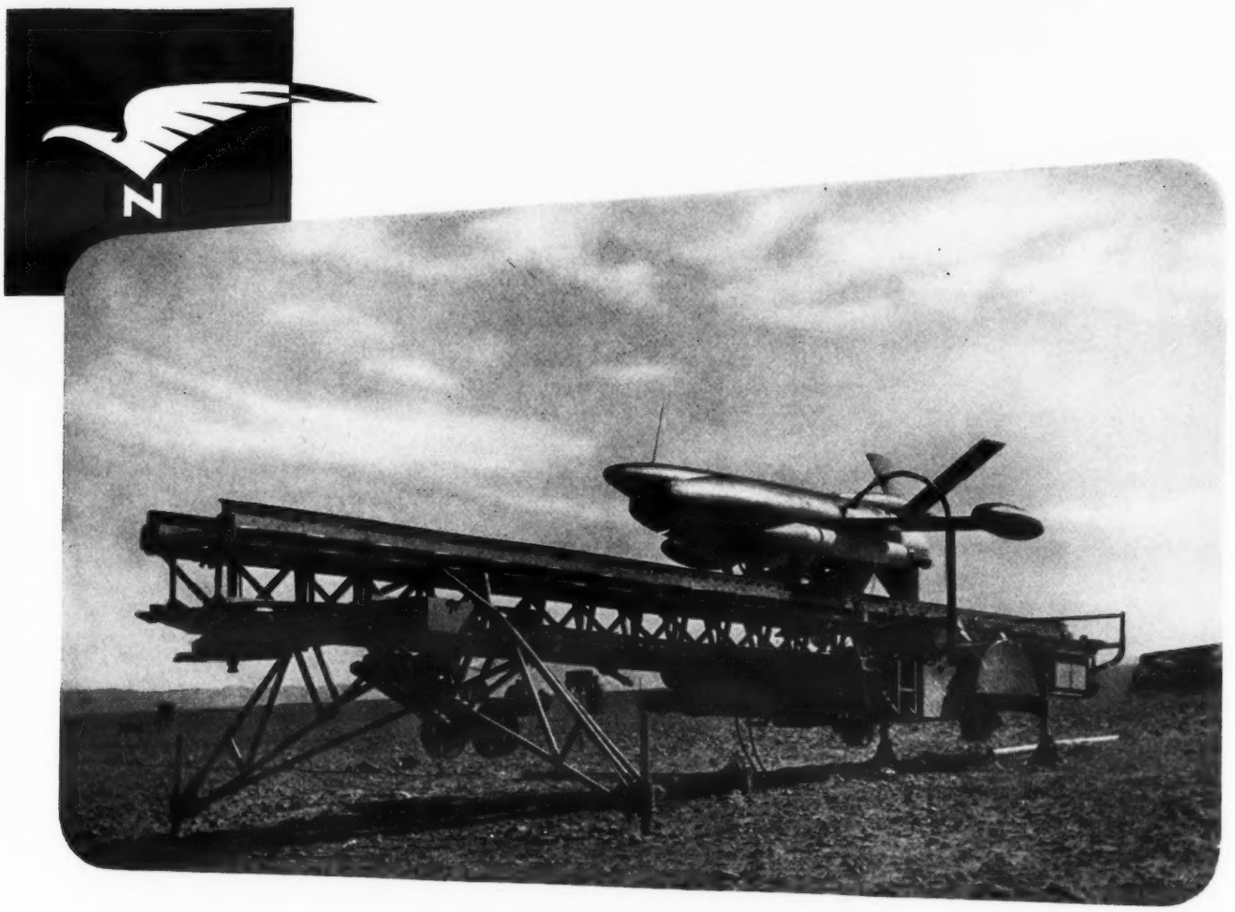

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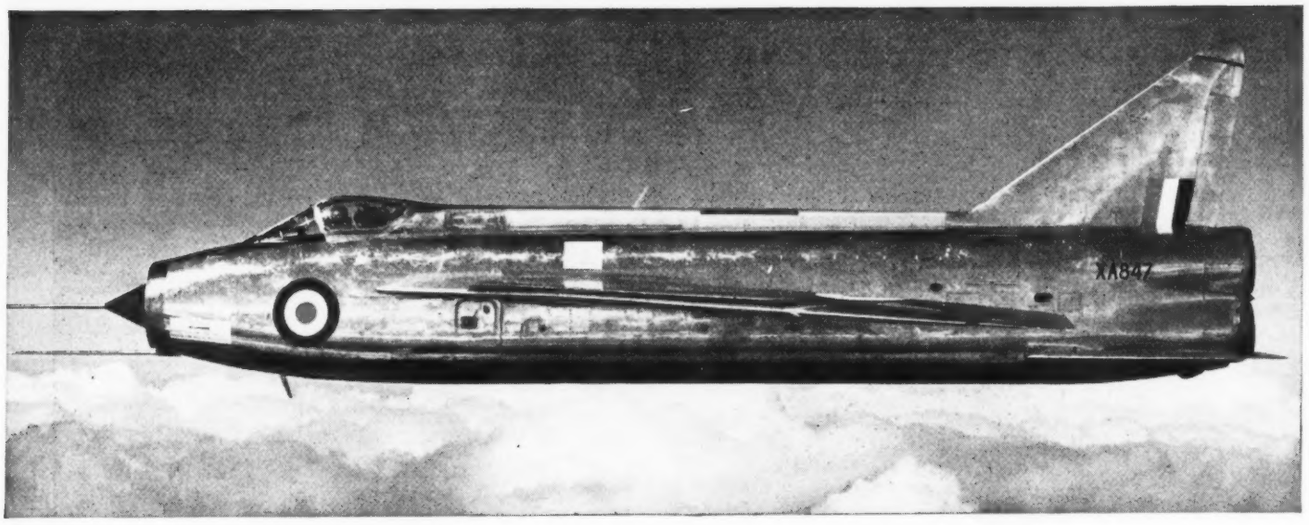

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The Deterrent Weapon in Navy or Air Force Uniform?

Something like six months ago we were asked by one of our printers whether we would be interested in publishing the German and French editions of a trade magazine on missiles and rockets which had been launched some two years earlier. With a certain regret we turned down the offer, for a number of reasons. Chief among these was the consideration that to cut the subject of missiles or space vehicles right out of the overall aviation picture would within a very few years prove to have been a false step. For one thing it would have mutilated *Interavia Review* as it now exists. As a clear outward sign of our editorial policy, it was therefore decided that the sub-titles of *Interavia's* publications should be changed from January 1st, 1959. Accordingly the monthly magazine now bears the sub-title "World Review of Aviation and Astronautics".

This almost forgotten incident was recalled by the reading of a striking article in "Newsweek" for February 2nd, 1959, dealing with the way in which the U.S. aircraft industry is adapting itself to its new tasks. The article begins as follows: "*Next Monday, Whitley C. Collins steps out as president of Northrop Aircraft and steps in as president of the Northrop Corp.*" This move on the one hand confirmed that we were not entirely on the wrong track when we changed our name and on the other proved something much more important: Northrop has no intention of giving up the manufacture of aircraft, which will continue at the Norair Division; space navigation systems are being developed at the Nortronics Division, and target drones by the Radioplane Division ... only the word "Aircraft" has been dropped, to reflect Northrop Corporation's wider field of interest. And who would affirm categorically that other companies may not shortly be making similar changes in their names?

Everything is in a state of flux, and companies are revamping both their organization and their manufacturing programmes. The situation is illustrated by the title chosen for one of the articles in this issue: "The Changing Role of the Aircraft Manufacturer in the Missile Age". Strangely enough, most Americans—perhaps including some of the shareholders in the various companies—seem to have little idea of the problems with which the heads of this major industry have been struggling for months past. Reports on new missiles, new supersonic bombers, new electronic systems, new concepts for air defence appear daily in the press; but ask the average American who makes these weapons, and he will have to confess his ignorance. He may not even know that a company in whose shares he is interested is facing new competition, not from abroad but from members of the U.S. automobile, rubber or electrical industries. To meet this competition, the aircraft industry is diversifying, and its members are developing into mammoth undertakings for equipment of all kinds, perhaps some day for civil goods which need not necessarily be airliners.

The "Newsweek" article quoted above culminates in the recognition that the old compartmentalism of companies is out of date in the space age.

*

Though only yesterday A and H bombs carried by six or eight-jet bombers were considered to be valid instruments of the American deterrent policy, today the military no longer appear to believe that weapons of this category can ward off the danger of attack. The budget for fiscal 1960 speaks plainly of new efforts: out of total estimated expenditures of $77 billion, no less than $40.9 billion—or 53 percent—is to be spent on defence ... "Our formidable air striking forces are a powerful deterrent to general war ... Great strides have been made in the development of ballistic missiles ... The *Atlas* intercontinental ballistic missile programme has been marked by rapid development ..." Mr. Khrushchev doubtless says much the same thing in a Russian accent.

Many writers have long been prophesying the demise of the manned bomber, and it now looks as if the Pentagon strategists have also come to the conclusion that manned bombers alone will not suffice for ever to deter a would-be aggressor. In the new defence estimates, procurement funds for aircraft have been cut to $6.6 billion from the $7.1 billion voted for the current fiscal year; although a total of 1,600 aircraft are to be built, this figure is already 150 lower than that for fiscal 1958, with a cut in expenditure on interceptors. When it comes to missiles, however, the opposite trend is revealed: the total of $3.4 billion earmarked for this item in the current year will rise to $3.9 billion in fiscal 1960, with more of the total being spent on production and less on development. Thus there is growing emphasis on missiles. But when it comes to strategic missiles, the experts do not yet appear to have been able to agree on whether these should continue to go primarily to the USAF's Strategic Air Command, or whether a good proportion of them should be given to the Navy. Can these reprisal weapons be preserved from destruction more surely by burying their launching sites underground or by camouflaging them under the seas? A third possibility would be to have manned aircraft carry them towards enemy territory and launch them from a stand-off position, thus preserving them from premature destruction.

"Mobility in Global War" is the expression used by our military correspondent, General of the Reserve Pierre M. Gallois, who discusses the Pentagon's new concepts in the present issue. This time the Air Force officer apparently hesitates to support his own service out and out and leaves open the question of whether in the near future the deterrent will wear Navy or Air Force uniform.

However, this is not the problem which is worrying the American aircraft industry. It has always been obliged and willing to work for all services. Its difficulties arise from the fact that Air Force, Navy and Army all constantly come up with new and more complicated demands. It might even happen that the Army, which has had increasingly miserly treatment in recent years, may also get a new role under the mobility concept. Although this may not yet be clearly discernible, it will perhaps emerge sooner or later, thanks to the "preference" of our age for so-called local conflicts.

EEH

Interavia Essay Competition

Announcement No. 2

The following is a breakdown by subjects and countries of the manuscripts received, as promised in the February issue (p. 143).

Of 235 participants

127 chose subject No. 1:
Air Travel for All

108 chose subject No. 2:
Guided Missiles or Piloted Aircraft?

The contributions came from 26 countries: Argentina (5), Australia (2), Austria (16), Belgian Congo (1), Belgium (16), Brazil (2), Canada (4), Czechoslovakia (2), France and Algeria (33), Germany, East (1), Germany, West (34), Great Britain (22), Holland (11), Hungary (1), India (2), Indonesia (1), Israel (1), Italy (12), Lebanon (1), Morocco (3), New Guinea (1), Pakistan (1), Spain (4), Switzerland (43), Vietnam (1), USA (10), others (5).

Further announcements will be published as required, whenever possible on the first editorial page of the issue concerned.

INTERAVIA S. A., Geneva

Mobility in Global War

By General Pierre M. Gallois, Paris

Who will wield the "big stick" tomorrow, the U.S. Air Force or the U.S. Navy? Will the USAF's multi-jet bombers—like the battleships of its surface rival—have only a few years in which they can play a decisive role, and then finish up on the scrap heap? If the manned bomber should disappear, will it be replaced by the USAF's ballistic missile operating from widely dispersed or underground sites, or by the Navy's ballistic missile carried to its launching point inside a submerged submarine moving at a speed of 28 knots? Or again, is it perhaps the B-58, which recently launched an experimental ballistic missile in flight, which points the way to the "absolute weapons system" on which America's deterrent policy will rest tomorrow?

There are plenty of reasons why so many questions arise today. Technological development is speeding up, and new weapons are being added to those of the past, though nobody yet knows what their respective operational values are, or when and how the transition can be made from old to new.

❶ In the field of long-range bombers the Soviet Union is making up for lost time. While hinting—and proving by spectacular demonstrations—that it has a proven technology in the matter of ballistic missiles, the USSR is reportedly still increasing the strength of its strategic air force.

Even if Russia reached a state of parity or achieved numerical superiority in bombers, this would not modify the "strategic equation" of the *status quo*. If both sides have an equally efficient defensive system, the nature of aeronuclear war is such that the initial attack is more difficult to perform than the reprisal. The aggressor must give first priority to attacking military targets, such as air bases, bombers, aircraft carriers, etc., which are more difficult to hit than the cities against which the reprisals would have to be directed. The minimum requirement for the aggressor would be numerical superiority in offensive weapons, coupled with a more efficient defensive organization. Then, and only then, could he hope to paralyse his opponent without fear of reprisals. To be successful in the aeronuclear age, the aggressor must be superior in both quantity and quality.

❷ But a new factor intervenes. *After years of effort, surface-to-air defensive missiles on both sides are beginning to achieve a certain efficiency. Reprisals by manned bombers will then become less easy to carry out, and the aggressor's chances will increase.*

❸ But the above would cease to hold good if, for example, the electronics experts succeeded, with the aid of their countermeasures, in throwing a spanner into the complex and sensitive works of a modern active defence system.

A manned bomber has a good chance of evading interception by missiles, thanks to the intelligence of its human crew and to the space it has available for countermeasure equipment. In that case the trial of strength reverts to the type outlined in paragraph 1 above. Once again the aggressor's chances of success become doubtful, since his skies risk becoming wide open to any reprisal forces which escape the initial attack.

❹ Next the airframe designers will go another step forward, developing their aircraft up to speeds of Mach 3, and once again altering the balance between the offensive and the defensive.

❺ In this battle between the bullet and the armour plate, the bullet has been winning since ballistic missiles have begun to join the arsenals of the Big Powers. Neither side, however, yet possesses an operational force of ballistic missiles.

Table I

Number of missiles required to destroy an underground missile base

Phase 1. Assuming that "mean accuracy" is 0.5 percent of the range (i. e. 35 km per 7,000 km), the following number of missiles must be launched to be sure of one direct hit:

Distance from target (km):	1,500	3,000	5,000	7,000
Number of missiles	21	43	75	111

(These missiles must be fired simultaneously, to avoid reprisals.)

It should be remembered, however, that in "practice" these figures would have to be increased to allow for numerous sources of error, such as errors in determining the exact location of the target, and functional unreliability of the missiles.

Phase 2. As the years pass ballistic missile engineering will also advance, and the "mean accuracy" may be reduced to 0.1 percent of the range, in which case the above figures will become:

Distance from target (km):	1,500	3,000	5,000	7,000
Number of missiles	4	8	15	20

Phase 3. Looking still further ahead we can assume a "mean accuracy" of only 0.05 percent of the range, when the number of missiles required would be:

Distance from target (km):	1,500	3,000	5,000	7,000
Number of missiles	1	2	3	4

Nevertheless, the race is already on between the precision of the aggressor's missiles and the survival ability of the reprisal missiles. On the attacker's side, the essential quality required of a missile is undoubtedly accuracy of aim. Unless he can use anti-missile missiles to intercept the reprisals, he must first destroy the enemy's launching sites, i.e., point targets. Hence the importance of precision. On the other side, the defender, as long as he too has no anti-missile missiles, can hope to escape only by preserving his reprisal forces from destruction. Remoteness of launching sites is not enough; they must also be dispersed, protected by concrete, later buried at a certain depth underground, and ultimately kept in a state of more or less permanent mobility.

Mobility, the absolute passive weapon, would deprive the attacker of the essential information he requires for aiming his missiles, namely knowledge of the geographical coordinates of his targets. This mobility, or to put it more clearly permanent concealment of the deterrent forces, would cost a high price in men and equipment. But if it could be achieved it would once again benefit the purely defensive party. The aggressor would be faced with an almost insoluble problem. If he still decided to attack, his victim would have little difficulty in annihilating his major cities, whose locations are accurately known. Moreover, since cities are vulnerable to the thermal effects of high-altitude explosions, they can be destroyed by a relatively small number of ballistic missiles. Once again, the aggressor would face a vastly more difficult task in launching his offensive, than the defender in conducting the reprisals on which he bases his safety.

Mobility of the reprisal potential, which tips the balance of force in favour of the country which is determined never to be the first to attack, is the U.S. Navy's most telling argument.

If the necessary decisions are taken without delay, and the corresponding funds appropriated, there will be "victory without war" in three years' time, say the Navy's supporters[1]. Recourse to force would be most

[1] "Victory without War 1958–1961", by George Fielding Eliot.

unlikely, since the aggressor would have a poor chance of neutralizing a reprisal force which moved beneath the surface of the seas.

The Air Force's answer is underground launching sites. During a recent conference Major General Schriever, Commander of the Ballistic Missile Divison, Air Research and Development Command, announced that *Thor* IRBMs could be launched from a tube buried vertically in the ground. This means that certain ballistic missiles with liquid propellants would have the same advantages as the solid-propellant *Minuteman* and *Polaris*.

Behind the underground reprisal missile looms the airborne launching platform—today represented by the B-58 firing an experimental ballistic projectile developed by Lockheed. Once more, the theory of permanent dispersion in the airspace is advanced. The system of perpetual motion by bomb-carrying bombers, which would be the only effective form of defence if Russian ballistic missiles became operational before the West's, would be succeeded by permanent patrols of bombers carrying ballistic missiles. Although this day is still far distant, it is already envisaged.

Thus each service has its trumps, which it plays out in turn.

Missile Accuracy versus Mobility of Target

Another question for consideration is that of the required consumption of offensive missiles as a function of target range and missile precision. Obviously a number of hypotheses have had to be accepted to simplify these calculations:

– The missiles which the aggressor wishes to destroy would be more advanced than those in existence today. They would be buried vertically in tubes whose mouths are at ground level. The area vulnerable to ground shock effects extends over a radius of 50 yards around the missile. No allowance has been made for the effect of debris thrown up by an enemy missile exploding in the vicinity.

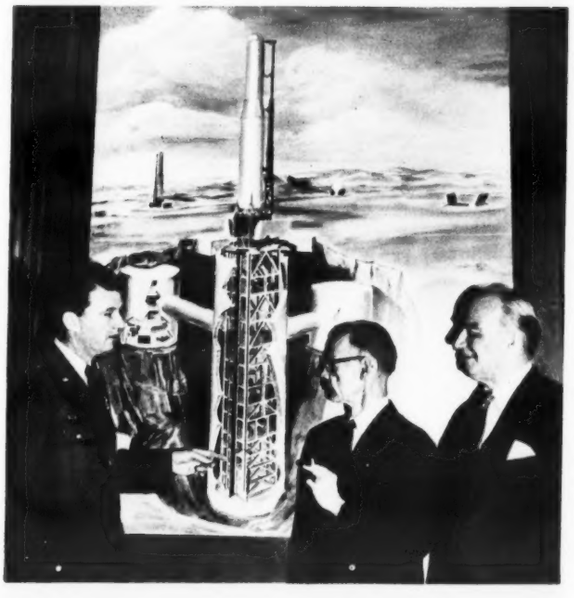
– The attacking missiles would have a nuclear warhead equivalent to one megaton. Technically speaking, a surface explosion would be possible, and its effects would extend to the edge of the plastic zone, i. e., to roughly twice the radius of the crater formed by the explosion.

– The distance between the individual launching sites is such that one attacking missile could not destroy more than one site.

– It has been assumed that the aggressor would know the geographic coordinates of the sites he wishes to attack and that all his missiles would function. The variables are: accuracy which, for reasons of simplicity, has been calculated as a percentage of the range[2],

[2] A "mean accuracy" of e.g. 0.5% of the range means that half of all the missiles fired would fall within a circle with a radius of 0.5% of the missile's range, while the other half would fall outside this circle. More accurate calculations would be based on an ellipse rather than a circle.

Who will wield the "big stick" tomorrow? The U.S. Air Force is ready with Northrop *Snark* intercontinental missiles, plus Douglas *Thor* and Chrysler *Jupiter* intermediate-range ballistic missiles (top picture). Convair B-58 *Hustler* supersonic bombers and Convair *Atlas* ICBMs will be coming into service shortly (lower picture).



Underground storage depots are to be built for the Martin *Titan* ICBM, though actual launching will take place from ground level. Here Major General Bernard Schriever, Commander of the Air Force Ballistic Missile Division, explains how the installation will function. His audience (and probable suppliers of the installation) are Chairman Morehead Patterson and Vice Chairman Walter Bedell Smith of American Machine & Foundry Co.

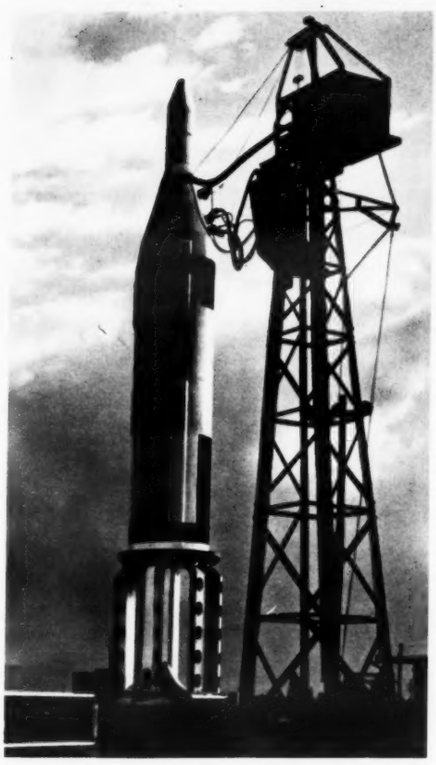
and the distance between the attacker's launching site and the target site.

Having accepted these hypotheses, let us examine the results of the calculation (see also Table I):

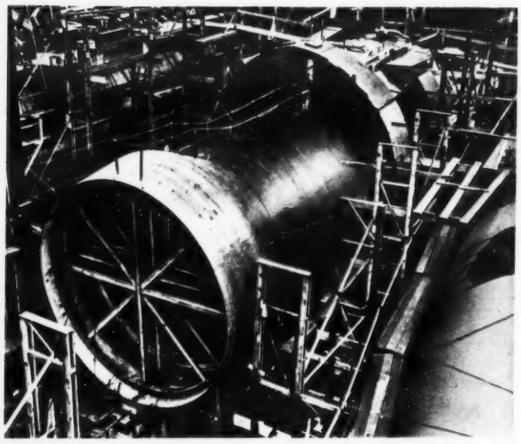
– If during the first phase the degree of inaccuracy is taken as 0.5 percent of the target range, for example, the number of offensive missiles required would vary between 21 and 111, as the distance to the target sites increased from 1,500 to 7,000 km.

– In a second phase it can be assumed that the mean error will be reduced. If some day it fell to the equivalent of 0.1 percent of the range, the two figures above would become 4 and 20. If it were technically possible to halve the error, one missile launched over a range of 1,500 km, or four missiles over 7,000 km, would suffice to ensure a high probability of destroying the target sites.

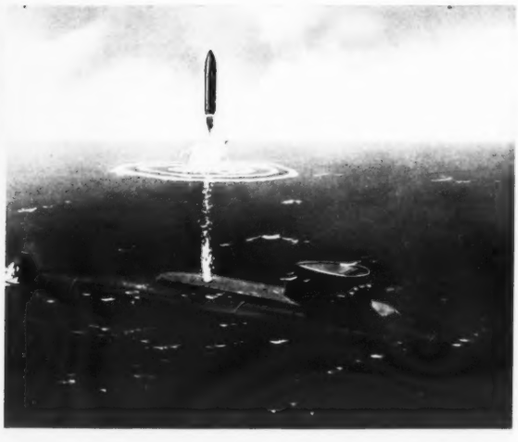
This is a far cry from the prohibitive consumption required today. However, by the time such a degree of precision is reached, the defence will be able to counter the threat by burying the reprisal missiles far underground or keeping them mobile in the air or under the seas. *Once the batteries to be destroyed are mobile, and their movements are not known, all counter-battery action becomes impossible. It follows that all-out armed conflict is out of the question, at any rate between the Big Powers, when each has an arsenal of nuclear ballistic missiles kept constantly on the move. "Victory without war," say George Fielding Eliot and the U.S. Navy.*



The Navy makes its bid with Submarine Squadron No. 14, each of whose nine nuclear-powered submarines will carry sixteen Lockheed *Polaris* IRBMs. Picture shows the AX-1 experimental version of the *Polaris* ready for launching.



The U.S. Navy's first nuclear-powered *Polaris* submarine will be completed in 1960. Each of these vessels is to carry sixteen *Polaris* IRBMs, which will be ejected from the hull by compressed air and ignited after emerging from the water.



The Navy's weapons

A new Naval unit, Submarine Squadron No. 14, was formed in July 1958. As an initial programme, nine nuclear-powered submarines, each armed with 16 *Polaris* missiles, will be built, with the first launchings scheduled for this year. This small fleet will cost more than half a billion dollars, excluding its armament, but this sum can be paid off over 15 or more years, since the operational life of these submarines is relatively long.

The U.S. Navy's arguments are substantial:

– The *Skate* has made a submerged cruise lasting more than a month. Starting out from Pearl Harbor, the *Nautilus* surfaced 17 days later off the south of Iceland after cruising for some one hundred hours beneath the Arctic ice cap. What better method can there be of escaping a surprise nuclear attack than by cruising thus under the surface of the seas or beneath the ice? What means could a potential aggressor use to neutralize reprisal forces which are so well concealed and so independent of fixed bases?

– Submarines are not so easy to detect as aircraft. Despite very recent progress, detection range for submarines cannot within the foreseeable future exceed tens of miles, whereas aircraft can be detected over distances of several hundreds of miles. Magnetic aerial detection has a certain efficiency but its range is very low.

– The bed of the oceans is less well-known than the atmosphere. The International Geophysical Year programme also included underwater exploration and three special vessels, the *Crawford* and the *Atlantis* (USA) and the *Discovery II* (Britain), traced some ten contours of the bed of the Atlantic Ocean. But, as Admiral Thach puts it, man is more familiar with the surface of the moon than with the bed of the seas. This general lack of knowledge complicates anti-submarine defence and consequently benefits the strategy of deterrence based on missile-carrying submarines.

– The *Polaris* missile has all the qualities needed for its mission. It is relatively small – some 30 feet in length – and is light in weight in relation to its range (roughly 13 tons). Its power of destruction is considerable, since a "broadside" of *Polaris* launched from a single submarine would have a destructive power greater than that of $^1/_{10}$ of all the bombs dropped on Germany throughout World War II. Submarine Squadron No. 14 alone would have a greater equivalent power than the British and American strategic and tactical air forces which attacked "Fortress Europe" during four years of war. These are of course theoretical figures which make no allowance for mis-fires or other technical difficulties.

– The technique of launching the *Polaris* from the submerged submarine has reportedly been perfected. The missiles are ejected from their housings (a series of cylindrical containers) by pneumatic pressure (compressed air or more probably steam), and the rocket cluster forming the first stage is ignited as the rocket leaves the water. An inertial system guides the missile on to its programmed trajectory which has been fed into the memory of a computer capable of allowing for both the geographical coordinates of the missile at the moment of launching and the coordinates of the assigned target.

– The submarine is a better launching platform than might be supposed. Inertial navigation combined with new methods of shooting the stars even when submerged provides a highly accurate method of navigation. The launching point can therefore be determined with adequate precision, in view of the probable ballistic errors on the one hand and the radius of destruction of a nuclear warhead on the other. When submerged the submarine is in a medium which deadens its oscillations, and the inertial navigation system is free of spurious accelerations. Roll is limited artificially, and an automatic pilot stabilizes the submarine on its course.

In response to these arguments it might be objected that despite recent increases in submerged speeds it would take time to get the missile-firing submarine into launching position. To travel from Alaska to the Norwegian coast, where it is scheduled to launch its missiles, a *Nautilus* would take no less than a week.

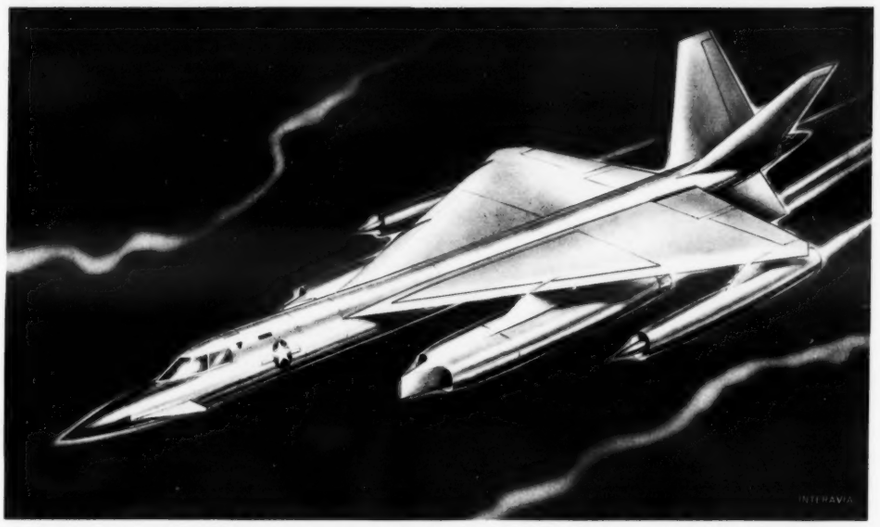
To which the submarine advocates have no difficulty in replying that such an objection overlooks the aims of the deterrent policy. This policy is not aimed at making war but at preventing it, by making sure that the risk to any aggressor would be greatly superior to the benefit he could derive from a nuclear conflict, since retribution would be inevitable. Once a potential aggressor knows that he faces the threat of fearful reprisals, which he can neither prevent nor intercept, he will be obliged to negotiate. As long as it is not impossible to stop or deflect a ballistic missile in flight and as long as its launching platform cannot be detected and travels beneath the surface of the seas, he will have to give up all idea of resorting to force since this would simply mean mutual suicide. All of which led Admiral Raborn of the Navy Bureau of Ordnance to say that if the *Polaris*-plus-submarine combination lived up to his expectations, only conventional war would be possible. In which case, added the Admiral, who knows what he wants, the Navy would have to have aircraft carriers.

It now remains to examine more closely the problem of the vulnerability of a submerged nuclear submarine and, more generally, of any submerged launching ramp.

*

Only experience will reveal the efficacy of a surface or underwater nuclear explosion aimed at destroying the underwater threat. Meanwhile, some very approximate figures, which will suffice at any rate to indicate the general order of magnitude of the effects of nuclear weapons in these conditions, can be obtained by using the rudimentary information provided in the U.S. Atomic Energy Commission's book entitled "The Effects of Nuclear Weapons," and by greatly simplifying the complex phenomena of underwater destruction.

Let us assume, for example, that there are two types of underwater target to which a would-be aggressor would have to give first priority if he wished to avoid becoming the second victim of his own attack: the submarine carrying nuclear missiles, and the



Will the B-70 *Valkyrie* supersonic bomber, now under development at North American and due for delivery to Strategic Air Command from 1963 onwards, look like this? At the moment, even the manufacturers themselves do not seem to have finally decided on the ultimate configuration of the Mach 3 bomber and its six General Electric J93 jet engines. However, *Interavia's* draftsman has put on his "long-range" spectacles and done his best. *Interavia drawing, copyright*

Table II

Radius of destruction of underwater explosions

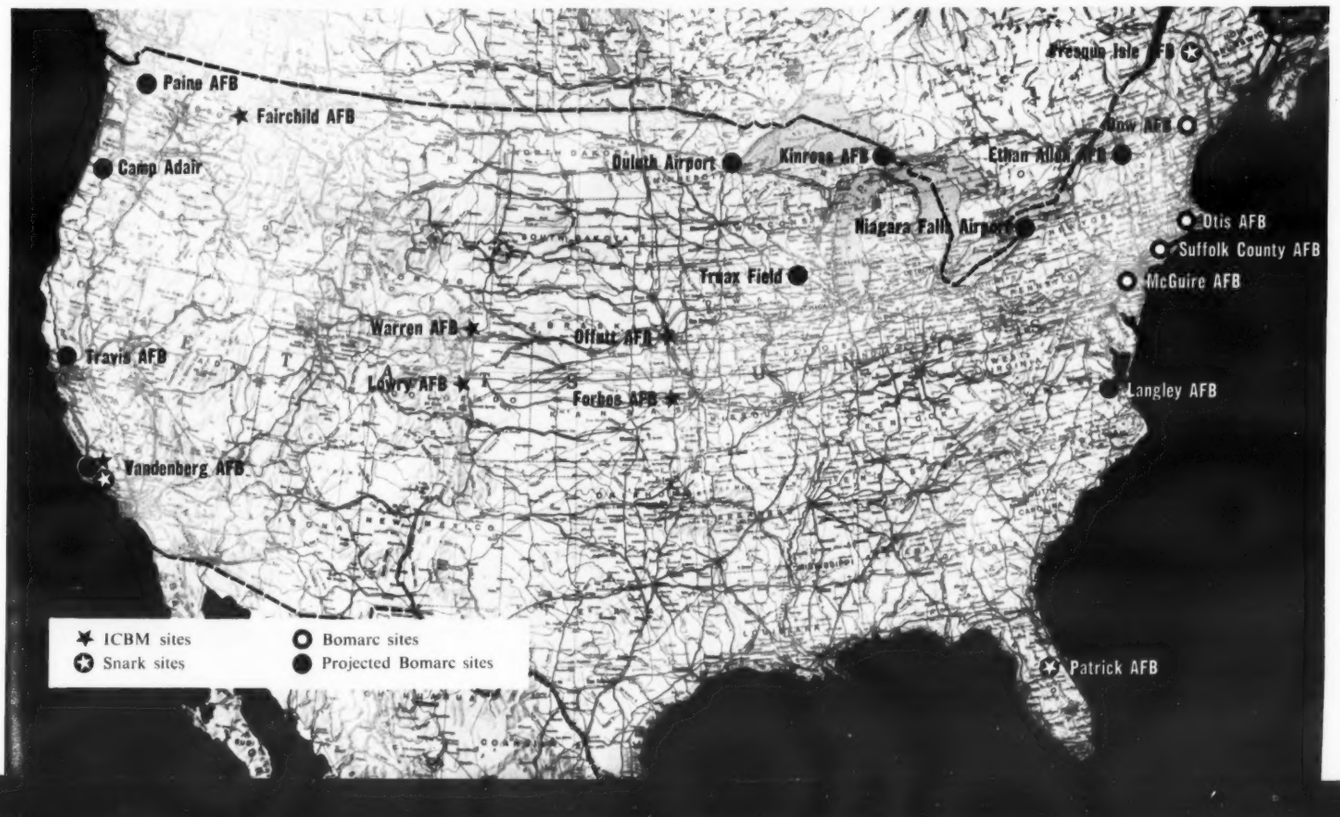
A. Against submerged submarines

Overpressure	Explosive yield 100 KT	1 MT	10 MT
10 kg/cm²	15 km	32 km	69 km
50 kg/cm²	3.35 km	7.2 km	15.5 km

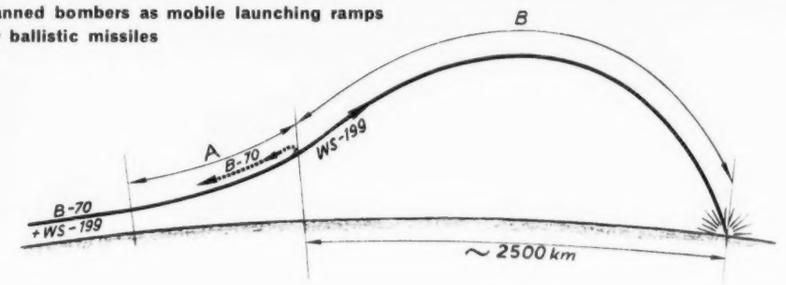
B. Against a missile-launching ramp in shallow waters

Overpressure	Explosive yield 100 KT	1 MT	10 MT
10 kg/cm²	4.45 km	9.6 km	20.8 km
50 kg/cm²	1.85 km	4 km	8.65 km

The widely dispersed launching bases for America's *Atlas* and *Titan* ICBMs (six bases) and for the *Snark* pilotless bomber (three bases). Also shown are four almost completed bases for the Boeing *Bomarc* and the planned location for ten other similar bases which have been approved by the Congress but not yet begun.



Manned bombers as mobile launching ramps for ballistic missiles



A first step towards the "ultimate weapon" may be the WS-199 weapons system, whose vital component will be a ballistic missile developed by Lockheed or Martin. It will be small enough to be launched by an aircraft.

Supersonic bombers, such as the B-58 and B-70, armed with this weapon could use the following tactics: having approached enemy territory to within something like 1,500 miles of their target, they would be manoeuvred by fully automatic controls into the requisite position and attitude for launching the missile (phase A), whereupon they would release the weapon, turn back and make off out of range of the enemy defences at top speed, while their missile continues on its ballistic trajectory (B) to the target.

ballistic missiles themselves, set up for launching in shallow water and fired by remote control.

It is assumed firstly that a high-power underwater explosion is possible and that the submarine to be destroyed is located in deep water (between 100 and 200 m). It is also postulated that some of its equipment would be damaged by a shock corresponding to an overpressure of 10 kg/cm². An overpressure of 50 kg/cm² would have decisive effects on the actual submarine, since it would greatly exceed the resistance limits of the hull. If at the moment of the explosion the submerged submarine were already under a pressure close to half of its static pressure limits, an overpressure of 50 kg/cm² would very greatly exceed the hull's resistance. Although nuclear depth charges would have a relatively low power—which is all that is required for the "milieu" and the nature of the target—it has been assumed that the attack would be made with high-power nuclear warheads, ranging for example from 100 kilotons to 10 megatons.

Calculations (approximate) reveal that the two overpressures selected would be obtained at distances which naturally vary with the power of the explosion and are indicated in Table II.

If the target to be destroyed were a missile on a submerged launching ramp at a depth of, say, 20 to 30 metres below the surface, and if the structures required to launch the missile (watertight container, compressed air tank, pipes and controls) were vulnerable to overpressures varying between 10 and 50 kg/cm², the figures shown in Table II indicate the effective area within which surface or underwater nuclear explosions could neutralize such a missile.

It will be seen from the distances over which these tremendous overpressures are obtained that the vulnerability of underwater targets may be greater than that of targets surrounded by air.

*

We are now in a position to compare the number of surface-to-surface launchings required with the number of surface-to-underwater missiles. If it is assumed that an overpressure of 10 kg/cm² would suffice to render the underwater reprisal missiles temporarily unserviceable or even to interfere with their reliability and accuracy, it will be seen that a very small number of missiles will be sufficient to destroy the enemy's underwater missile launching ramps. Table III shows that the number of missiles required varies between one and nine, depending on the distance to be covered, the explosive power and the location of the underwater target to be destroyed.

*

Though a fixed underwater launching site can be located in advance and fairly easily neutralized, the missile-launching reprisal submarine presents the aggressor with an almost insoluble problem because of its mobility and the secrecy of its movements.

Table III

Number of missiles required to destroy an underwater target

The table gives the results of an approximate calculation for the consumption of surface-launched missiles, based on a "mean accuracy" of only 0.5 percent of the range.

Number of missiles to be launched						
Explosive yield	100 KT		1 MT		10 MT	
Distance (km)	1,500	3,000	1,500	3,000	1,500	3,000
Underwater targets						
Stationary submarine	1	2	1	1	1	1
Ballistic missile launching site	4	9	2	4	1	2

A comparison of these figures with those given above for the destruction of an underground launching site reveals the greater vulnerability of the underwater target. The table below presents an overall picture of these results:

Distance	1,500 km	3,000 km
Explosive yield	1 MT	1 MT
Number of missiles to be launched to damage		
– an underground launching site	21	43
– a stationary submarine	1	1
– an underwater launching site	2	4

To neutralize a threat of reprisals by missile-carrying submarines cruising for example off the coast of Norway, within an area some 1,000 km long and 500 km wide, some 300 to 400 ballistic missiles with ten megaton warheads would have to be launched. To be reasonably certain of success, the area under fire would have to cover virtually all the waters from which these submarines could launch missiles on their continental targets. Although water transmits shock-waves from explosions over considerable distances, the reprisal submarine's mobility would force the aggressor to use roughly the same number of missiles as would be needed to destroy some 200 to 300 underground launching sites. In any case, it would appear impossible to attack all submarines at the same moment, and the offensive forces required would be prohibitive. In short, the submarine as an instrument of deterrence would have solid virtues.

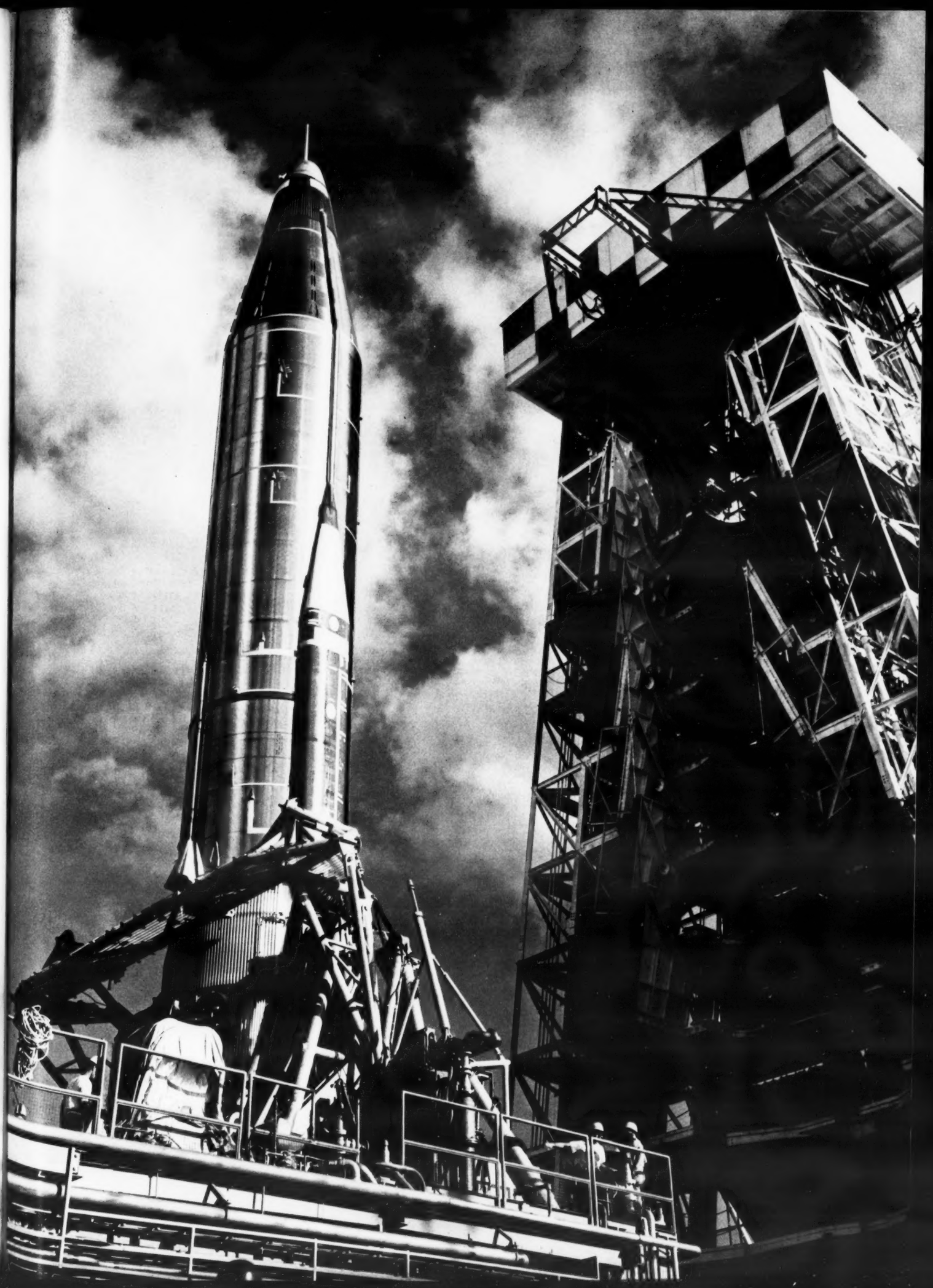
But before the U.S. Navy's optimism can be widely shared, projects must be translated into solid engineering, all the difficulties involved in launching the *Polaris* from its submarine tubes will have to be overcome, its parent submarine will have to be capable of extremely accurate navigation and be perfectly stabilized at the moment of launching, and finally submarine detection will have to remain as difficult as it is today. A central control system would also have to be organized for this constantly moving missile-launching fleet, which would have to be in permanent contact with the U.S. Government.

If the U.S. Navy believes that it will one day possess the supreme weapons system, the USAF is also convinced that it can achieve this position by remaining faithful to its trend of development.

It opposes the *Polaris* with its project *Bold Orion*, on which both Lockheed and Martin are working. As counterpart to the 5,000–6,000 ton submarine, the USAF proposes to give a new lease of life to the B-52 and the B-58 by transforming them into launching platforms for ballistic missiles, later adding the B-70. The USAF hopes the nuclear-powered bomber will become a reality in the not too distant future, when it will have a launching ramp which can be kept permanently on the move in the airspace. Assuming that the problem of accurate navigation and accurate location of the required launching point is solved, this would really constitute a "supreme weapon" because it would be virtually indestructible. But both the USAF's and the Navy's projects will require many more years of planning and technical and financial effort before they can be put into practice.

And it may well be that one day a USAF spokesman can adopt the words of Admiral Raborn and say "If the *Bold Orion*-plus-bomber X combination lives up to our expectations, only conventional war will be possible; in which case," the Air Force, which is also on the ball, will add: "we shall have to broaden the scope of our air armament." Naturally at this future date, as today, wisdom will dictate that both solutions be applied and both types of armament acquired.

An *Atlas* ICBM ready for launching at Cape Canaveral Missile Test Center. ▶



The Role of the U.S. Navy

The impressive cruises by U.S. submarines *Nautilus* and *Skate* under the Polar ice cap have not only proved that nuclear-powered underwater vessels can move from the Pacific to the Atlantic Ocean in only a few days, but have also demonstrated two other facts of vital importance for the future of the U.S. Navy: modern submarines, operating entirely independently, can remain submerged for weeks on end and if necessary stay concealed beneath the thousands of miles of Polar ice cap. Thanks to highly accurate inertial navigation systems and other new underwater navigation aids[1], submarines are now capable of cruising in the most difficult waters, feeling their way along the bed of the sea near the coast and taking up any required position with the highest accuracy.

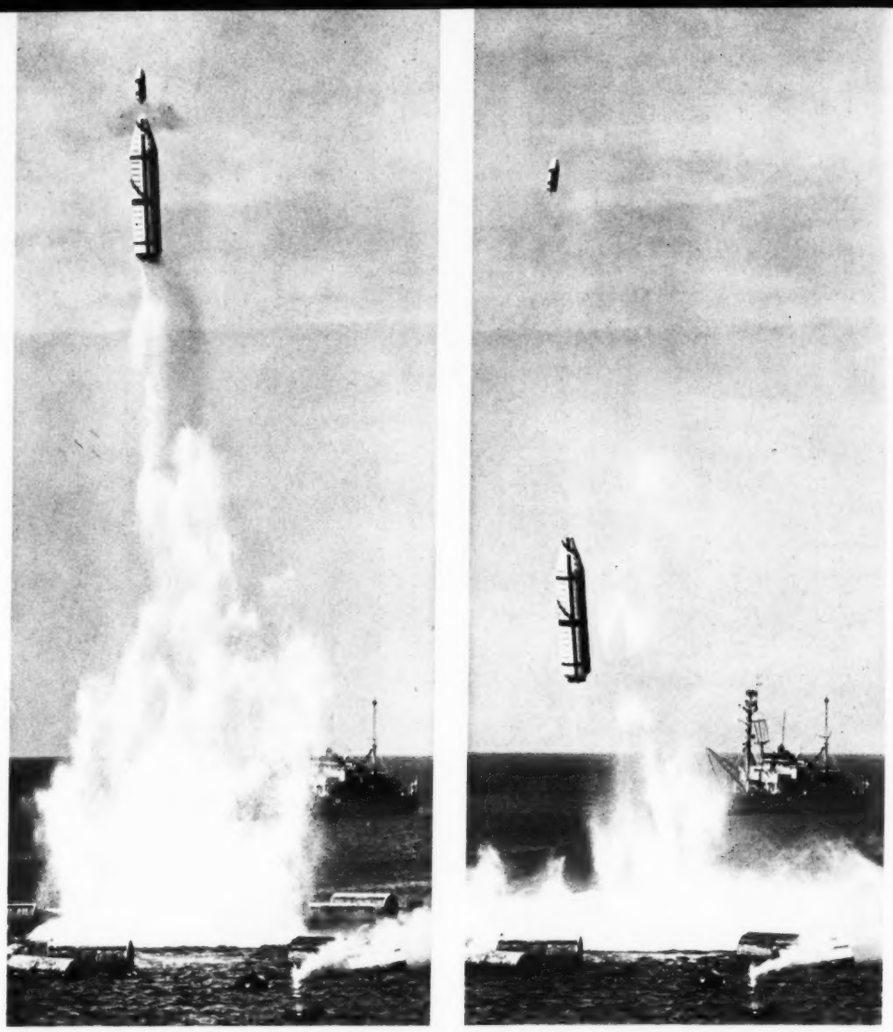
It was obvious that these new capabilities would revolutionize naval warfare, and that submarines of this kind would be used as carrier vessels for long-range ballistic missiles. And it was not surprising that the U.S. Navy should have immediately cut down its long-term programme for surface vessels in favour of a fleet of rocket-firing submarines—particularly as the Bureau of Ordnance's preliminary investigations and the research work carried out by Lockheed and Aerojet promised early availability of solid-propellant IRBMs for underwater launching, which would weigh less than a third as much as a *Thor*.

So it was that the Navy, some time before the *Nautilus* and *Skate* Polar voyages, set about developing a mighty weapons concept which immediately brought it into direct competition with the Air Force; this programme covers 5,400-ton submarines of the SSG(N)FBM class which have an almost unlimited range and can carry sixteen *Polaris* IRBMs inside their 380-ft. hulls.

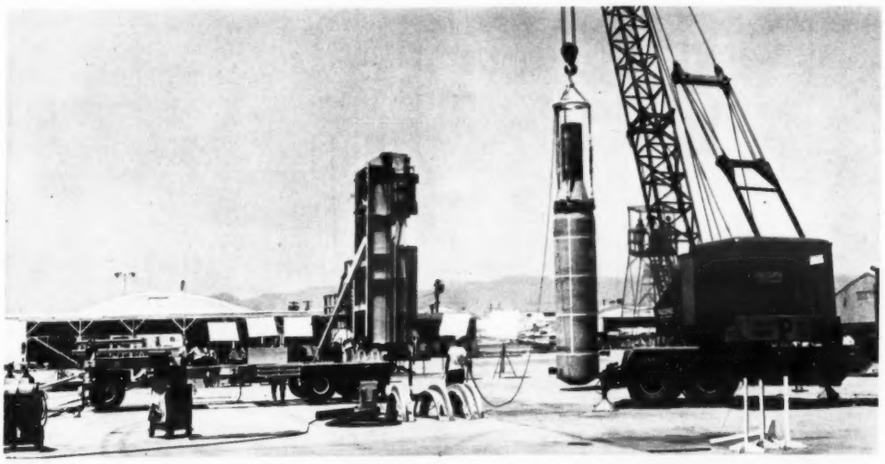
Needless to say the arms race between the Air Force and the Navy will necessitate additional American defence efforts, particularly as the Navy shows no inclination to give up its programme of giant aircraft carriers and has developed the new North American A3J carrier-borne supersonic bomber specially for these carriers. For the *Polaris* programme alone, funds totalling $1,300,000,000 have been appropriated during the current fiscal year, or nearly 40 percent more than for the Air Force's *Atlas*, *Titan* and *Minuteman* ICBMs together.

But the Navy's new weapons programme is not a parallel development to the Air Force programme. It is based on the formula of *mobile reprisal forces* and follows this objective more consistently than the USAF's present missile concepts. Admittedly the *Polaris* IRBMs to be fired from advanced floating bases would have similar tasks to perform as the *Atlas* or *Titan* intercon-

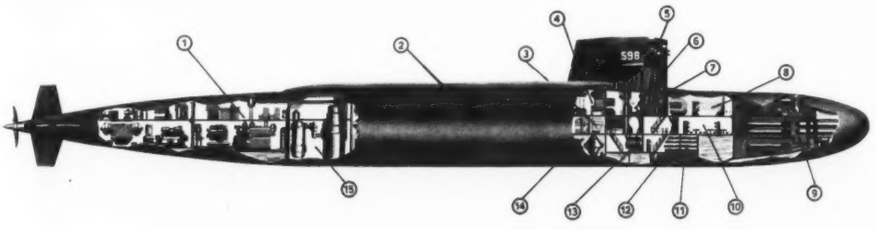
[1] Cf. *Interavia* No. 8, 1958, pp. 809–810.



The U.S. Navy has fired more than 25 research rockets and experimental models under the *Polaris* programme, some of them from a launching tube anchored on the sea bed. The two above pictures show the missile shortly after emerging from the water, and the separation of the second stage from the first stage, which would, however, take place at a higher altitude in the final weapon. The prototype illustrated below has the same configuration as the production model. The picture also shows the erector trailer for ground handling.



Cutaway drawing of a *Polaris*-carrying submarine of the SSG(N)FBM class. The 380-ft. boat has a displacement when surfaced of 5,400 tons and will be powered by a Westinghouse atomic reactor and turbines. 1. engine room; 2. missile room; 3. missile control centre; 4. navigation room; 5. bridge; 6. periscope room; 7. control room; 8. officers' ward-room; 9. forward torpedo room; 10. crew's mess; 11. crew's quarters; 12. batteries; 13. stores; 14. gyro room; 15. reactor room.



The Chance Vought F8U-1 *Crusader* supersonic fighter aboard the USS *Saratoga* super carrier.

Maiden flight of the North American A3J *Vigilante* supersonic bomber, powered by two General Electric J79-2 jets. The bomber costs more than its weight in gold.

tinental missiles, and the A3J *Vigilante* operating from nuclear-powered super carriers would initially have to attack the same enemy bases and supply centres as the B-58 *Hustlers* taking off from SAC bases. But as the floating *Polaris* bases would not be marked on any staff map and could take up position unperceived at the edge of the oceans, they would not become the immediate targets of the enemy's super weapons, as would the fixed ICBM launching ramps. What is more, they would be more likely to reach their targets than the ICBMs fired from nearly 6,000 miles away. The same applies to carrier-based supersonic bombers of the A3J category, which would approach their targets from secret take-off locations and return to find their carrier probably undamaged.

There is certainly no desire here to belittle SAC or cast doubt on the efficiency of its long-range bombers and missiles, but the fact remains that the Navy will have its first missile submarines operational by 1960–61, whereas years of effort will be required before the Air Force can have a deterrent force of comparable mobility. The combined B-70-plus-WS-199 weapons system will probably not be operational until 1963.

Considering the funds involved in the Navy's long-range missile projects and the advanced stage of development of the *Polaris*, it is surprising to note how much less vociferous the Navy is than the U. S. Air Force in promoting its rocket programme. It is only a few months since a semi-official American publication[2] defined the U.S. Navy's main tasks as follows: "The Navy's mission is to gain, maintain and exploit control of the sea. Types of warfare and operations in which the Navy is expected to engage—in fulfilment of its mission—are: 1. Combat operations at sea, which include the operation of sea-based aircraft and land-based naval aircraft. 2. Land operations essential to the prosecution of a naval campaign. 3. Air operations as necessary for the accomplishment of objectives in a naval campaign." It is also stressed that the Navy's mission is closely tied to that of the Army, at least in so far as the transport of troops to overseas destinations is concerned. Apart from a drawing this article says nothing about the Navy's new strategic deterrent weapons. No word is spoken about the *Polaris*-carrying nuclear-powered submarines which account for roughly one eighth of the total Navy budget; no word on carrier-based supersonic bombers of the A3J *Vigilante* type which can at all times deal surprise tactical and strategic blows against the enemy's rear. Presumably the Navy is not keeping silent out of false modesty.

[2] "Military Review," September 1958, p. 10.

From the U.S. Navy's Construction Programme for 1959—60

Surface Vessels and Submarines

Name	Standard displacement (tons)	Speed (knots)	Completion scheduled for	Armament
Super Carriers				
Enterprise (nuclear-powered)	85,000	40	1961	8 Terrier dual launchers, approx. 200 aircraft
Kitty Hawk	60,000	35	1960	8×5-in. anti-aircraft guns, 170 aircraft
Constellation	60,000	35	1960	
Guided missile cruisers				
Long Beach (nuclear-powered)	14,000	45	approx. 1960	Regulus II, Talos, Terrier, Tartar
Guided missile destroyers				
DLG(N) 25 (nuclear-powered)	7,000	45	—	Terrier II, 3-in. A. A. guns
10 DLG (Nos. 20—29)	4,000	34	1960—62	Terrier, 3-in. A. A. guns, anti-submarine weapons
10 DLG Farragut class (Nos. 6-15)	3,900	34	1960—61	Terrier II, 3 and 5-in. A.A. guns, anti-submarine weapons
18 DLG Charles F. Adams class (Nos. 2-19)	3,370	35	1959—61	Tartar, 5-in. A.A. guns, anti-submarine weapons
Nuclear submarines				
2 SSG(N)[1]	4,250	—	—	Undisclosed missiles
2 SSA(N)[2]	2,850	—	—	—
2 SSK(N)[3]	2,450	—	—	—
6 SSG(N)FBM	5,400	—	1960—61	16 Polaris, torpedoes
3 SSG(N)FBM	—	—	from 1961	Polaris
SSK(N) Tullibee	2,450	—	1961	—
3 SSG(N) Permit class	4,250	—	1961	Regulus II
SSK(N) Thresher	3,250	—	1960	—
6 SSA(N) Skipjack class	2,850	50	1960	Special torpedoes
SSG(N) Halibut	2,900	—	1959	Regulus II

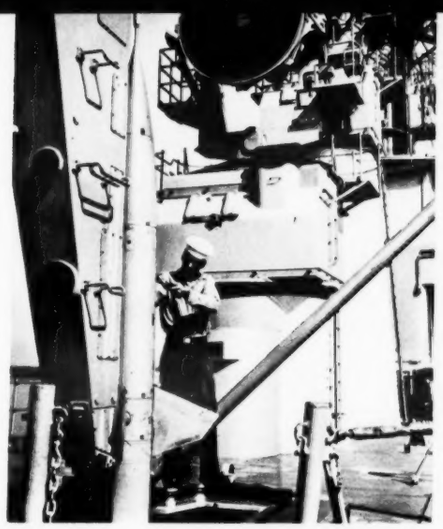
Aircraft, Guided Missiles

Supersonic all-weather fighters and fighter-bombers: McDonnell F4H and Chance Vought F8U-2N
Supersonic attack aircraft: North American A3J
Air-to-air rockets: Philco Sidewinder, Raytheon Sparrow III, Project Eagle (Bendix)
Anti-aircraft rockets: Convair Tartar, Convair Terrier I and Terrier II, Bendix Talos
IRBM: Lockheed Polaris

[1] Guided missile submarine [2] Attack submarine [3] Killer submarine

On January 10th, 1959, USS *Independence* (CVA-62), the fourth large aircraft carrier in the *Forrestal* class, went into service. The picture shows the *Independence* at the New York Naval Shipyard, before being handed over.

Drawing of a modern American escort cruiser which, equipped with extensive radar equipment and missiles of all types, could assume the defence of large aircraft carriers against air attacks.



Aboard the *Boston* guided missile cruiser: A *Terrier* anti-aircraft rocket is brought up automatically from the magazine below decks and placed on a loading rail; the wings are installed and it is then moved into firing position.

The *Canberra* cruiser is also equipped with *Terrier* rockets, which are being built by Convair under contract to the Navy Bureau of Ordnance. The 15-ft. long *Terrier* weighs 2,760 lb., including its booster. A land-based version with mobile trailers is being used by the U.S. Marine Corps.

The present issue seems a good place in which to submit the latest Navy developments to a closer scrutiny.

The central item in the naval construction programme for the coming years is of course the class of submarines designed to carry the *Polaris* IRBM. Six of these vessels are already on the stocks, and one of them will be going into service in about a year's time. As already indicated in the February issue of *Interavia*, the Navy recently announced plans to have General Dynamics Corporation build additional missile-launching submarines, which will be still heavier and longer than the 5,400-ton boats now under construction. The first vessel of this new type is to cost no less than $105 million; the SSG(N)FBM class of submarines will cost $50 million or more apiece. A total of nine nuclear submarines have been authorized under the *Polaris* programme, and the following shipyards will be involved in their manufacture: Electric Boat Division (General Dynamics Corp.), of Groton; Mare Island Naval Shipyard; Naval Shipyard Portsmouth; Newport News Shipbuilding Yards.

Of course, the *Polaris* project is only one of the major items for the Navy's future arsenal. As well as special naval vessels and landing craft of all types for the Naval Task Forces, aircraft carriers and escort vessels for large naval units, the Navy also has a series of other interesting special vessels on the stocks. High priority is being given to the 252-ft. nuclear-powered attack and killer submarines of the *Skipjack* class, extremely fast and manœuvrable vessels with a surface speed of 50 knots and a submerged speed of 30 knots, which are specially equipped for detecting and combating enemy submarines. Carrying supplies, oxygen and other reserves for a cruise of 60,000 nautical miles, these boats, designed to the latest hydrodynamic standards, are especially suitable for the pursuit and destruction of missile submarines and the destruction of missile-launching tubes anchored to the sea bed. They would also have an important role to play in the protection of aircraft carrier units against attacking submarines. They not only supplement the detection and combating of submarines by means of sonar buoys and aircraft, but also permit the use of completely new methods of anti-submarine warfare, which cannot be employed by aircraft because of weight and space limitations.

Another category of submarine vessels is represented by the *Skate* class (displacement when submerged 3,000 tons; surface speed 30 knots). These are 268-ft. multi-purpose vessels designed to operate at great depth, armed with special torpedoes and equipped for reconnaissance tasks, the laying of sonar buoys and of underwater nuclear warheads. The Navy also has a series of radar picket submarines for airspace and sea surveillance, and in addition a number of diesel-electric submarines are being converted to operate the *Regulus II* missiles which have already been produced. As is known, the *Regulus II* production programme has been cancelled in favour of the *Polaris*, but the existing missiles are gradually to be used up and would of course be fired in the event of war.

Other vital items in the Navy's future arsenal are the six giant aircraft carriers of the *Forrestal* class, the biggest units in the construction programme with a maximum displacement of 76,000 tons and a deck length of 1,045 ft. They carry up to 170 aircraft and can remain at sea for months on end with a complement of 3,870 men. Their aircraft will consist of the latest carrier-borne types armed with guided missiles, including the McDonnell F4H equipped with *Sparrow III* air-to-air missiles and the North American A3J *Vigilante* supersonic bomber. The recent introduction of carrier-based tanker aircraft (North American A2J *Savage*) makes it possible to carry out missions which carrier-borne aircraft have hitherto been unable to tackle, such as triangular flights originating from one carrier and terminating on another. When these super carriers receive their first A3Js in about a year's time, it will be

USS *Gyatt* (DDG-712), America's first guided missile destroyer, went into service in December 1956. To make it possible to fire *Terrier* rockets under all weather conditions, the cruiser is equipped with two extendable stabilization floats under the water line, which damp pitching and yawing in heavy seas.

The *Skate* nuclear-powered submarine (3,000 tons) represents the first operationally equipped attack submarine, and is at the same time the model for other nuclear submarines in its class. The *Nautilus* and *Seawolf* experimental vessels were also built by the Electric Boat Division of General Dynamics.

difficult to say whether the Navy's *Forrestal* class aircraft carriers are tactical or strategic weapons. They will be the first units to arrive at the scene of any trouble and will be able to assume a wide variety of tasks. Should the United States be obliged at some time to give up certain SAC bases in North Africa or the Middle East, the replacement bases would bear the names *Forrestal*, *Saratoga*, *Ranger*, *Independence*, *Kitty Hawk* and *Constellation*. And the strategic aircraft for these floating bases would then be not the B-47 or the B-58, but the A3J *Vigilante*.

The fact that not only the Bureau of Ordnance, but also the Pentagon, is convinced of the special mission of the aircraft carrier is confirmed by the continuation of the 1954 *Forrestal* construction programme through to 1961, so that in about two years the USA will have more than a hundred aircraft carriers available—including the escort carriers now in "moth-balls". A still clearer proof of this conviction has been provided by the Congress and the Administration in their approval of history's biggest ship-building programme: the $314 million nuclear-powered giant aircraft carrier *Enterprise*, of 85,000 tons standard displacement (about 100,000 tons maximum displacement), is scheduled for completion in record time by 1961; it will be equipped with eight (!) atomic reactors and Westinghouse turbines, and be capable of a speed of 40 knots. The length of its deck will be no less than 1,100 ft., and air attacks will be dealt with by eight dual launchers for *Terrier* anti-aircraft missiles and numerous escort cruisers and destroyers, also equipped with guided missiles.

Apart from the nuclear submarines and a number of special vessels, the American naval construction programme for the coming year will concentrate on these gigantic aircraft carriers and their escort vessels. The latter include the *Long Beach* nuclear-powered guided missile cruiser, armed with *Talos*, *Tartar* and *Terrier* anti-aircraft missiles, and with *Regulus II* surface-to-surface missiles, as well as numerous cruisers of the *Boston* and *Galveston* classes, converted to launch anti-aircraft missiles, new missile destroyers of the *Charles F. Adams* and *Farragut* classes, and the DLG(N)25 nuclear-powered destroyer leaders with a speed of 45 knots. Also included are numerous completed naval units of all classes, to be equipped with guided missiles and converted to meet the requirements of atomic warfare at sea.

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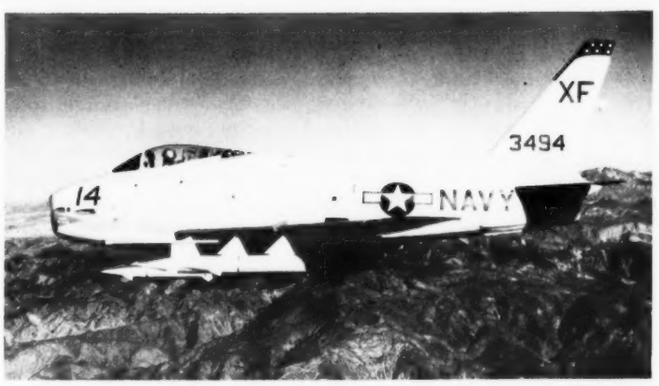
Grumman F11F-1 *Tiger* supersonic fighters are operated from both aircraft carriers and U.S. Navy land bases.



North American FJ *Furys* now carry six *Bullpup* guided missiles.

The U.S. 7th Fleet's McDonnell F3H-2 *Demon* carrier-borne fighters in the Pacific use Raytheon *Sparrow III* air-to-air rockets with radar homing head.

The naval tanker *Allagash* refuelling the canted-deck aircraft carrier USS *Essex* (CVA-9). The three escort destroyers are also waiting to be refuelled.

Almost unperceived by the strategists of land warfare, but fully appreciated by naval experts in West and East, the U.S. Navy has been undergoing a transformation. Both its weapons and its missions have been fundamentally modified. It is beyond the scope of this article to describe in detail the alterations in the structure of the naval units and their new arsenal. Suffice it to say that the U.S. Navy and the U.S. Marine Corps today form the most versatile fighting force in the Western world, which can at all times hasten to trouble spots. Their new role as operators of strategic weapons means greater efforts in several technological fields for the U.S. Navy. A far-reaching mission which will be all the more difficult to perform as the Navy cannot neglect its other important functions, namely intervention in local conflicts and containment of the Eastern *bloc's* numerically superior land forces in the event of a major war.

The Changing Role of the Aircraft Manufacturer in the Missile Age

The most striking evidence of the accelerating trend away from manned aircraft and towards missiles is provided by the fact that whereas in 1954 the U.S. Air Force was spending about 90 percent of its procurement dollar on aircraft and only 10 percent on missiles, the percentage of total procurement money now spent on missiles has risen to nearly 35 percent. In fiscal 1959 U.S. missile spending will total $3.4 billion (compared with $500 million in 1954), with nearly $7.2 billion going on manned aircraft.

Thus the past five years have seen a growing transformation in the aircraft industry's production programme. Not only has the industry had to invest huge sums in the weapons system concept for modern combat aircraft, but it has also spent heavily on research and development of missiles for the U.S. Air Force. Though such efforts may in the long run lead to success, they are not immediately paying propositions. And despite the fact that the shift to missiles appears to be sharper than previously predicted, U.S. missile spending is not yet large enough to depend upon wholly. Hence the aviation companies are of necessity steering a precarious course between missiles and aircraft.

The Lockheed Aircraft Corporation, headquartered in Burbank, Calif., presents an interesting case in point. Although Lockheed had done some earlier work in missiles research, it first established its Missile Systems Division (recently renamed Missiles and Space Division) in 1954 in Van Nuys, Calif. From a nucleus of a few hundred scientists and engineers, the missile division has grown to include a personnel of over 12,000. With the Navy's *Polaris* missile and other contracts it still has a great growth potential. Under the leadership of General Manager L. Eugene Root, a corporate Vice President, the Lockheed Missile Systems Division officially moved its headquarters north to Sunnyvale, Calif., on the San Francisco peninsula, in 1957. At its research and development centre in Stanford Industrial Park, Palo Alto, it is aiming at diversification and working in the fields of electronics, propulsion, and nuclear energy. In 1954 missile work accounted for only one percent of Lockheed's total sales, by 1957 this figure had climbed to 8 percent, and for the first half of 1958 it was 27 percent.

It can easily be seen that this trend portends drastic shake-ups in personnel, budgeting, and long-range planning throughout the industry. The research scientist, for instance, has become more indispensible than ever. The total U.S. defence research and development effort has increased from $3.4 billion in fiscal 1955 to $5.6 billion in fiscal 1958. Aircraft and missiles account for more than half of the latter figure, with aircraft R & D costing one billion dollars, and missile R & D costing $2.1 billion. In addition, the aircraft industry itself is spending heavily on research. In the ten years following the end of World War II it invested one billion dollars of its earnings in research and development programmes and facilities for aircraft and missiles, and at the present rate will have invested at least another one billion by 1961.

New competitors for the aircraft manufacturers

The industry insists that there is no dividing line between aeronautics and astronautics, and that astronautics follows logically from aeronautics. Missiles consist of the same basic elements, propulsion, guidance, and airframe, with which the aircraft industry is highly experienced. This opinion is seconded by Dr. Theodore von Karman, Chairman of the NATO Advisory Group for Aeronautical Research and Development, and one of the fathers of rocket engineering (he founded Aerojet and engaged in considerable propulsion research). Von Karman points out that the space age "is essentially an extension of our activities in the same direction that science and technology followed in the last half century." He is convinced the solution of the new problems will be speeded by using "the experienced staffs of the companies now engaged in aircraft and engine design and production."

The aircraft industry would like to see that it gets primary air weapons systems responsibility, but it is apparent that the one-time "monopoly" of the aircraft industry on "things that fly" is being strained. Causing the aircraft industry great concern is the emergence of new competitors, many without previous aviation experience. Among these can be listed the automobile, electronic and rubber companies.

The General Tire & Rubber Company, for example, has an important subsidiary in the Aerojet-General Corporation of Azusa, Calif., while a relatively new subsidiary of the Ford Motor Company is Aeronutronic Systems, Inc., of Glendale, Calif. Yet another "outsider" which comes to mind is the Chrysler Corporation, of Detroit, who not only has plans for "flying jeeps", but is also building giant rockets.

The uncertainty about the aircraft industry's future is not relieved by high ranking Air Force officials who declare that future prime contracts may go to propulsion and electronics firms rather than airframe producers. In addition, many of the traditional aircraft suppliers are now competing with their clients. Examples can be found in two propulsion firms, both suppliers that have set up special organizations to handle missiles. One, United Aircraft Corporation, has established a Missiles & Space Systems Division, and Allison Division of General Motors has formed a Missiles Systems Department. And in return, the aircraft firms are competing with their suppliers. For instance Courtlandt S. Gross, President of Lockheed Aircraft, points out his company has been giving serious consideration to moving into both the solid rocket and electronic component fields.

Gross maintains that non-aviation companies who are seeking to enter the aviation business are a direct threat to the survival of organizations that supplied the successful aerial weapons of World War II and the Korean War. "We are already faced with a limit on the dollars available for procurement of aircraft, missiles, and space vehicles. All of the traditional aviation companies are having a hard enough time trying to survive on the money the Army, Navy and Air Force have to spend. If additional companies start

competing for the limited cash available, everyone will suffer, and some companies may even be forced out of the aviation field," Gross predicts.

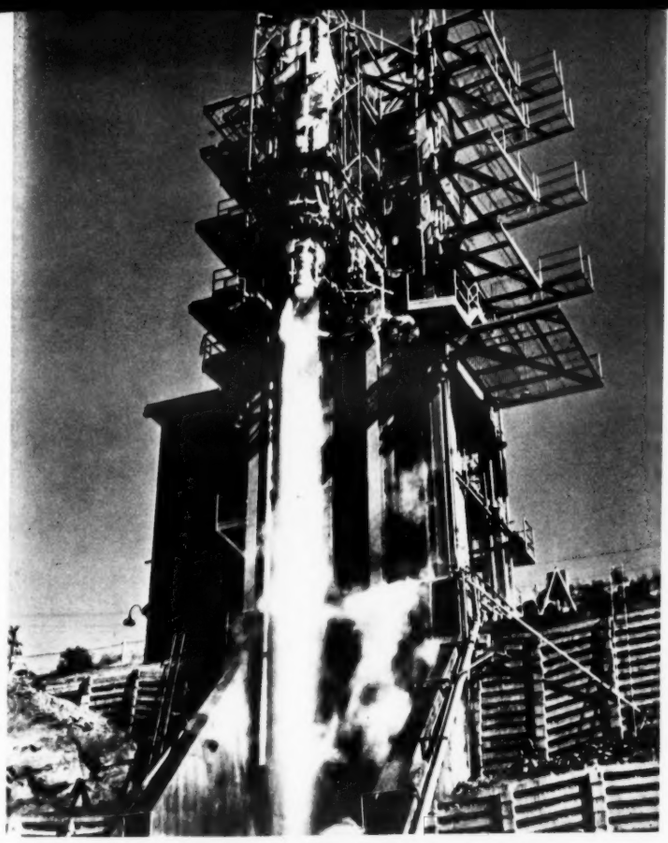
The aircraft industry's answer to this situation is to diversify. For instance, North American Aviation Inc. has established a wide variety of divisions or subsidiaries—Missile Development Division, Autonetics Division, Rocketdyne Division, Atomics International Division—to enable it to act as subcontractor or associate contractor for systems and components in the structural, electronic, rocket engine and atomic energy areas. Many other companies, including such names as General Dynamics, are diversified to the same or a greater degree.

Airframe manufacturers still leading in missiles

At the present time the aircraft industry is responsible for about 90 percent of the research, development and production of guided missiles. This is no accident, say industry leaders; they prepared the way. Companies long known only as airframe manufacturers have become leaders in propulsion, in guidance, and atomic energy applications.

More than forty missile projects, ranging from small air-to-air missiles to huge intercontinental ballistic missiles, had been announced by the U.S. military services by the end of 1958. One example is illustrated by the following picture report on missile activity at Douglas Aircraft Company.

Today there is a considerable lack of knowledge throughout the U.S. as to the responsibilities of the aircraft industry in the design, development and production of missiles for the nation's defence system. For example, according to a recent survey of Opinion Research Corporation, Princeton, N.J.,



An Army rocket on the test stand at the Rocketdyne Propulsion Field Laboratory, Los Angeles. ▲

Producing combustion chambers for liquid-propellant rocket engines at Aerojet-General. ▶

◀ In spring 1958 the Convair-Astronautics Division of General Dynamics Corporation was transferred to a new plant northeast of San Diego, California. This space division provides work for more than 7,000 employees.

▼ Mass production of the *Atlas* ICBM at the Convair Division of General Dynamics Corporation.

only 37 percent of the U.S. population thinks that industry has played an important role in the development of missiles, and two out of every three persons were unable to identify the manufacturer of any guided missile.

Weapons system concept and team approach

Other forces at work to change the traditional role of the aircraft company are the weapons system concept and the team approach to development and production. The weapons system concept has been discussed so often in these pages that there is no need to describe it in detail here. Both the armed forces and industry support this concept as the only feasible technical approach to developing modern complex weapons.

The team approach, where companies band together on projects from the time of the original proposal, constitutes a kind of re-insurance policy against financial or technical demands which would be beyond the reach of individual manufacturers. For example, the team responsible for the Dyna-Soar boost glide aircraft, led by the Martin Company, also includes Bell Aircraft, Bendix Aviation, Goodyear Aircraft, Minneapolis-Honeywell, and American Machine and Foundry. A second industry team is headed by Boeing Airplane Company. The necessity for team work is also illustrated by a recent statement of Wellwood E. Beall, Boeing Airplane Company Senior Vice President, who pointed out that Boeing probably lost out to North American on the B-70 chemical bomber because it tried to take on too much of the job by itself. "From now on," says Beall, "we'll be using the team approach on bids for complex weapons systems."

Financing

Traditionally, the industry has relied on payments from aircraft deliveries to finance its operations. Now it is assuming larger burdens of financing its

contracts, customers, its research and its facilities. To survive tough competition and keep up with fantastically rapid technological change, aircraft companies in recent years have re-invested 60 percent of their earnings, more than any other manufacturing industry.

This additional financial burden is difficult when earnings are falling. Though sales of the twelve major airframe manufacturers were about $7.0 billion in 1958 compared with $6.9 billion 1957, earnings continued to decrease. The average net profit, as a percentage of sales of the twelve companies, decreased steadily from 3.7 percent in 1954 to 2.4 percent in 1957.

*

Missiles, space vehicles, weapons systems and other new developments set the U.S. aircraft industry before serious problems. It is now fighting a battle on three fronts, organizational, technological and financial.

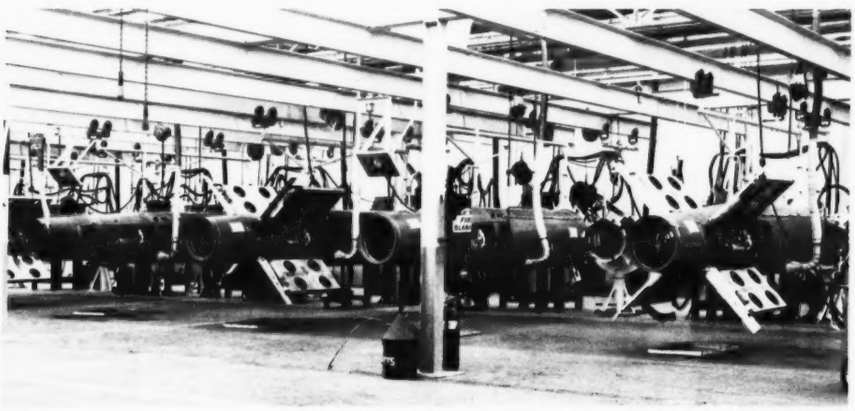
However, it must not be forgotten that this industry—with certain exceptions—has the following advantages on its side: young in years, it has yet proved itself to have the most enterprising and courageous management which any industry could hope to possess. It has attracted the cream of America's scientists and engineers to its research and development centres. The major proportion of the world's airlines utilizes its products, and—of considerably greater importance—without it the Pentagon's whole planning effort would be doomed to failure. Unlike the automobile industry, it is to a certain extent armed against economic crises through its dependence on Government contracts. Finally, as it is still not too heavily in debt, it can count on Wall Street support.

Final assembly line for the Army's Nike Hercules *surface-to-air missile at the Douglas Charlotte plant.*

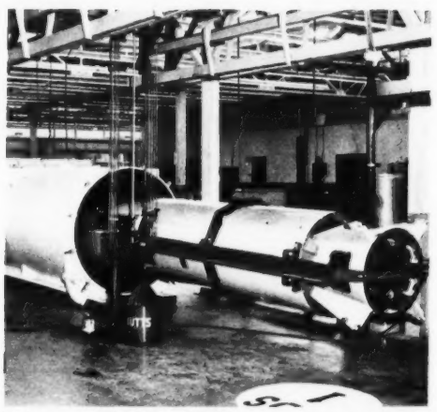
Douglas Aircraft Corporation has been remarkably quick in getting firmly established in the guided missile field and in converting a considerable portion of its production facilities to the manufacture of large and small rockets. In cooperation with other members of the aircraft industry and with a large number of equipment plants specializing in missile work, Douglas is main contractor for missile projects for all three services. Examples from the very presentable list of contracts are the Honest John *artillery rocket, the nuclear-warhead* Genie *air-to-air missile, the* Nike Ajax, Nike Hercules *and* Nike Zeus *surface-to-air missiles and the WS-315A* Thor *IRBM weapons system. The present picture report illustrates the production of the* Nike Hercules *rocket at the Douglas Charlotte Division and the beginning of quantity production of the* Thor *IRBM at Santa Monica.*

Missile

HERCULES

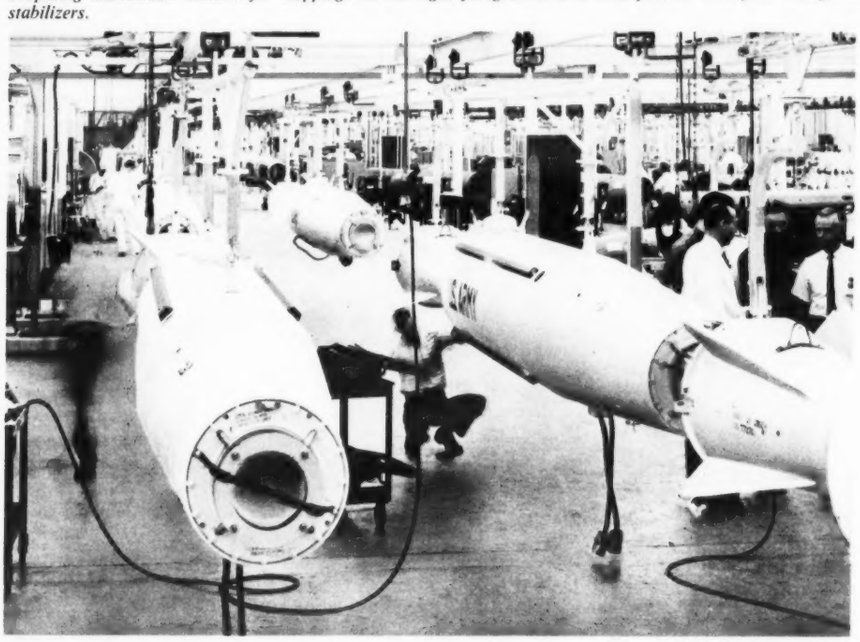


Final check-out of the Nike Hercules *in the final assembly shop. Special equipment tests the missile's functioning under simulated operational conditions.*

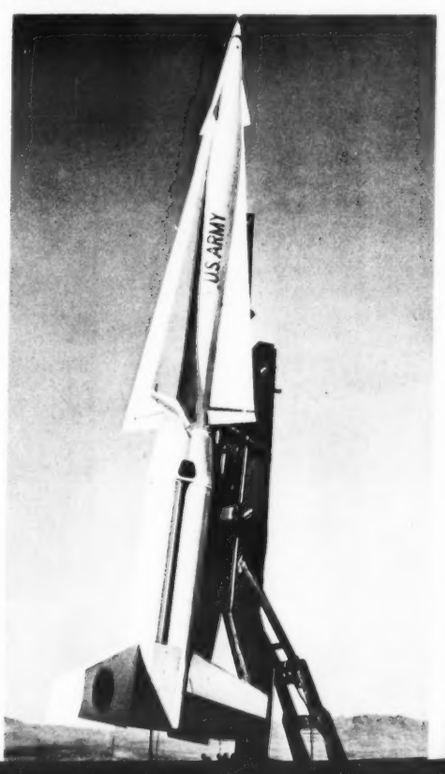


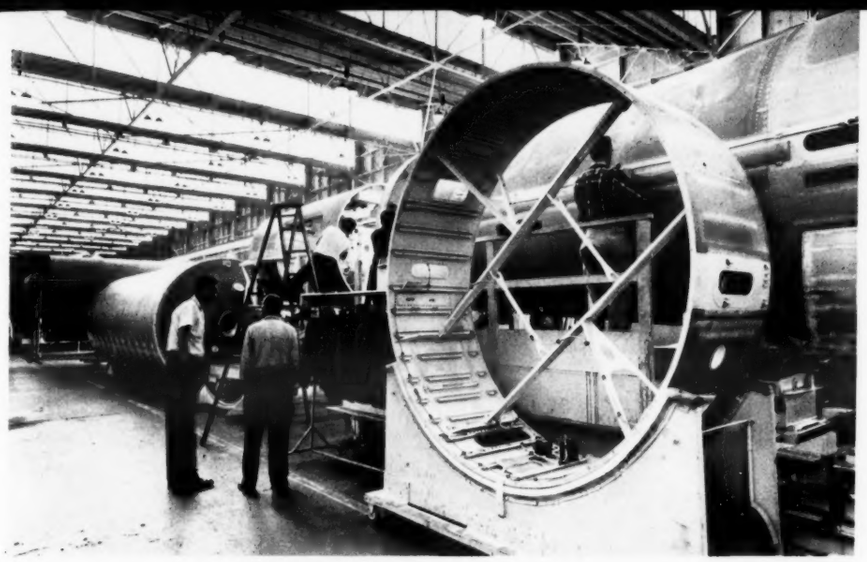
The main section and nose cone, with the latter inserted in the main section to conserve space, are loaded in a special container for shipment.

Preparing dismantled missiles for shipping. In the right foreground is a nose portion with four cruciform stabilizers.



The complete Nike Hercules *with its four-barrel booster on its launcher.*



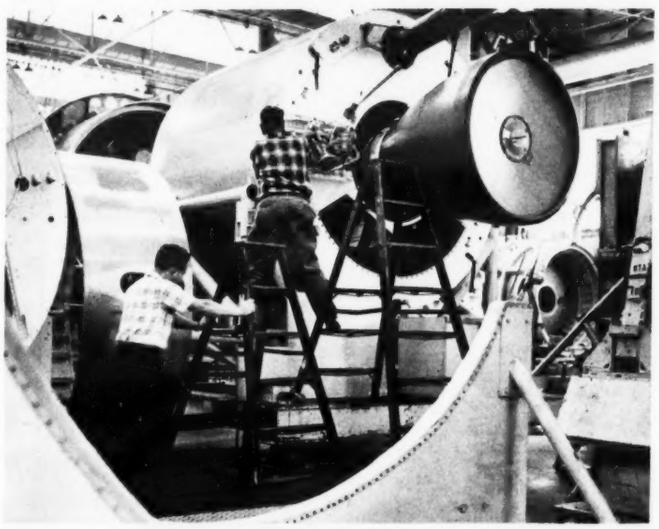


Body sections and fuel tanks for the Thor *IRBM.*

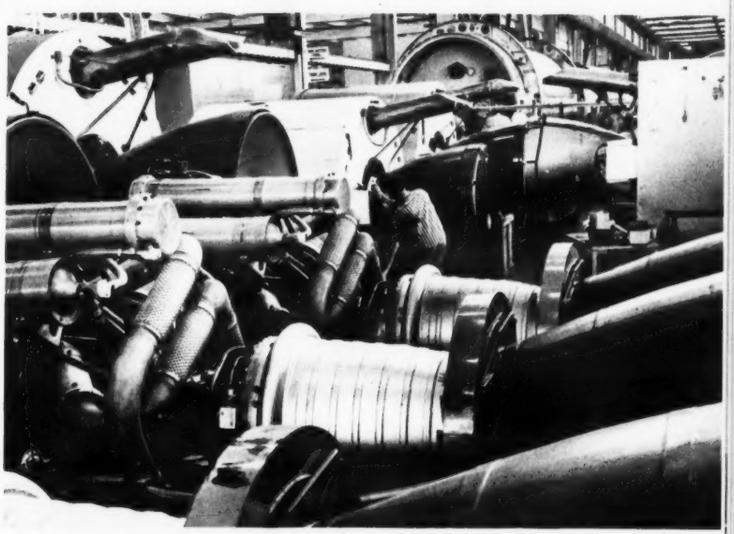
Inside one of the body sections; rings, stringers and riveting recall aircraft fabrication methods.

Production at Douglas

THOR

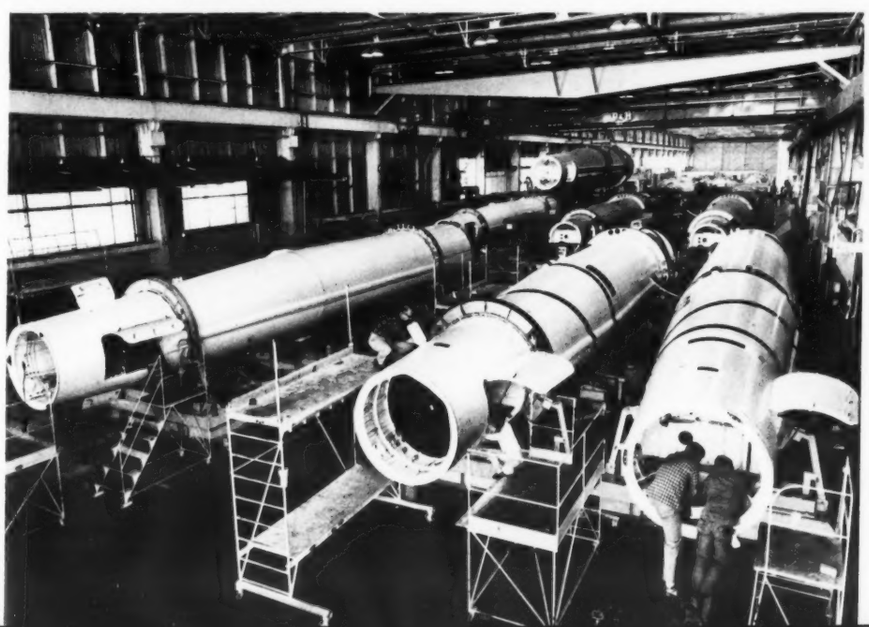


Mounting a gimballed vernier rocket for thrust vector control. Next to it is the mighty jet pipe of the main power unit.

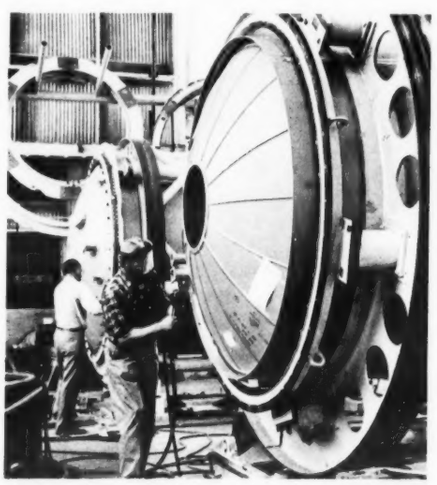


Each of these Rocketdyne rocket motors (type designation MB-3/XLR 79 NA-9) for the Thor *delivers roughly 150,000 lb. of thrust.*

Thor *missiles in final assembly at the Douglas Santa Monica plant: the rear sections with engine bearers and vanes, and the nose cones are fitted later. At the front of the main sections are maintenance doors giving access to the electronics and guidance equipment.*



Working on the "lids" of the propellant tanks, which illustrate the diameter of the Thor.



No Luke-Warm War with a Strong Air Defence

By Colonel A.T. King, Jr.

"If the submarine *Polaris* weapons system comes up to our expectations," says the U.S. Navy, "peace between the Soviet Union and the United States will be inevitable. If nevertheless there is war, it will be of a limited nature."

"If we succeed, in a few years time, in perfecting the combination of a nuclear-powered bomber and an air-launched ballistic missile, large-scale aggression will become impossible," argues the Air Force. "The *status quo* will be maintained between the Great Powers, and if there is any trial of strength it will be localized."

To which the U.S. Army retorts: "Since the engineers are producing atomic weapons of smaller and smaller power and there will soon be very little difference in power between the biggest TNT weapon and the smallest nuclear weapon, we shall be capable of stopping all forms of conflict, from the most limited to the most serious, simply because we will possess a range of weapons wide enough to cope with any kind of conflict. All we shall need to do is to get to the scene of a threatened war. This is where the Strategic Army Corps will come in, with its striking power and the mobility which air transport confers upon it. If the prospect of a rapid intervention by STRAC does not suffice to make a would-be aggressor think twice, then the battle will be won with the aid of surface-to-surface missiles such as the *Redstone*, the *Little John* and the *Lacrosse*, the *Spad* anti-tank gun, the 105-mm mortar and finally aircraft from the Army and the Air Force."

But three facts now intervene to modify this new strategy even before it has been fully formulated. These facts are the following.

I. At White Sands a Raytheon *Hawk* missile destroyed a Lockheed Q-5 drone flying at 1,400 m. p. h. and at an altitude of over 32,000 ft.

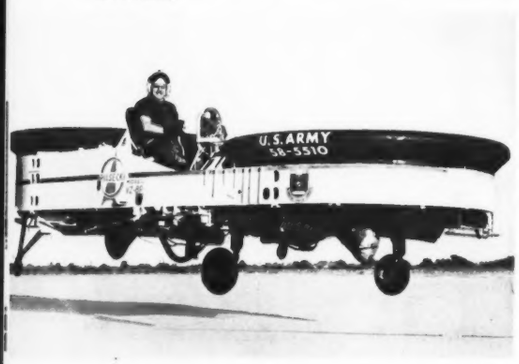
The *Super Hawk* will be superior in altitude and of course in range to the *Hawk*, which is designed for use against aircraft at low altitude and at a range of up to 20 miles. But it has already been proved that surface-to-air missiles, even without atomic warheads, can destroy aircraft flying at above 1,200 m. p. h.

II. On December 19th, 1958 a *Bomarc* missile fired almost to the limit of its range successfully intercepted a target drone, this time a *Shooting Star*.

III. As if it, too, had been waiting for an opportunity to show its paces, a *Nike Hercules* the same day destroyed a Q-5 drone at an altitude of more than 65,000 ft. and a speed reported to have exceeded 1.800 m. p. h.

A U.S. Army Sikorsky S-56 *Mojave* helicopter transports a 5-ton M-56 self-propelled gun platform. This armoured vehicle, designed for airborne operations, can be equipped for example with the 106-mm weapon shown here, or with a 90-mm anti-tank gun.

VZ-8P *Sky-Car* flying jeep, developed by Piasecki for the U.S. Army.



The European position

Hawk, *Nike Hercules* and *Bomarc* are to be included in the Western European air defence system. The *Hawk* will guard the skies at low altitudes and up to short distances, and the *Nike Hercules* at high altitudes and over medium distances; as for the *Bomarc*, its long-range capabilities are known. Between them these three will defend the airspace almost from ground level up to an altitude of several miles, so that there will be little room for manned interceptors. In any case the problem of coordinating the activities of both aircraft and missiles would be formidable, since the wartime airspace would probably be a good deal more congested than the busiest peacetime air routes.

If the ballistic missile did not exist, the dream of the European pacifists who argue that an adequate defence system can be built up without the possession of reprisal weapons would become almost a reality. Any aggressor would have to be prepared to lose a large portion of his forces and could not launch a surprise attack since it would be impossible to assemble sufficient forces in secret. But the ballistic missile does exist. If used against Western Europe, it would be accurate enough to achieve results, in view of the destructive power of its nuclear warhead.

In Western Europe these surface-to-air missiles, which can be used only against piloted aircraft, have one effect: they would oblige a would-be aggressor to use offensive ballistic missiles. The advantage for the defence would be meagre, since a small number of high-power nuclear missiles would probably be enough to break Western Europe's will to resist and create the state of atomic chaos where no organized defence is possible.

A similar situation arises for the reprisal force. If Strategic Air Command already credited the Soviet Union with having a defensive system as powerful as the United States will have one day, it would have to base its deterrent power on two factors:

- an increasing number of manned bombers, so as to saturate the defences (which at the same time would have to be jammed by electronic counter-measures);
- the use of ballistic missiles, against which the Russian equivalents of the *Bomarc* and the *Nike* are entirely powerless.

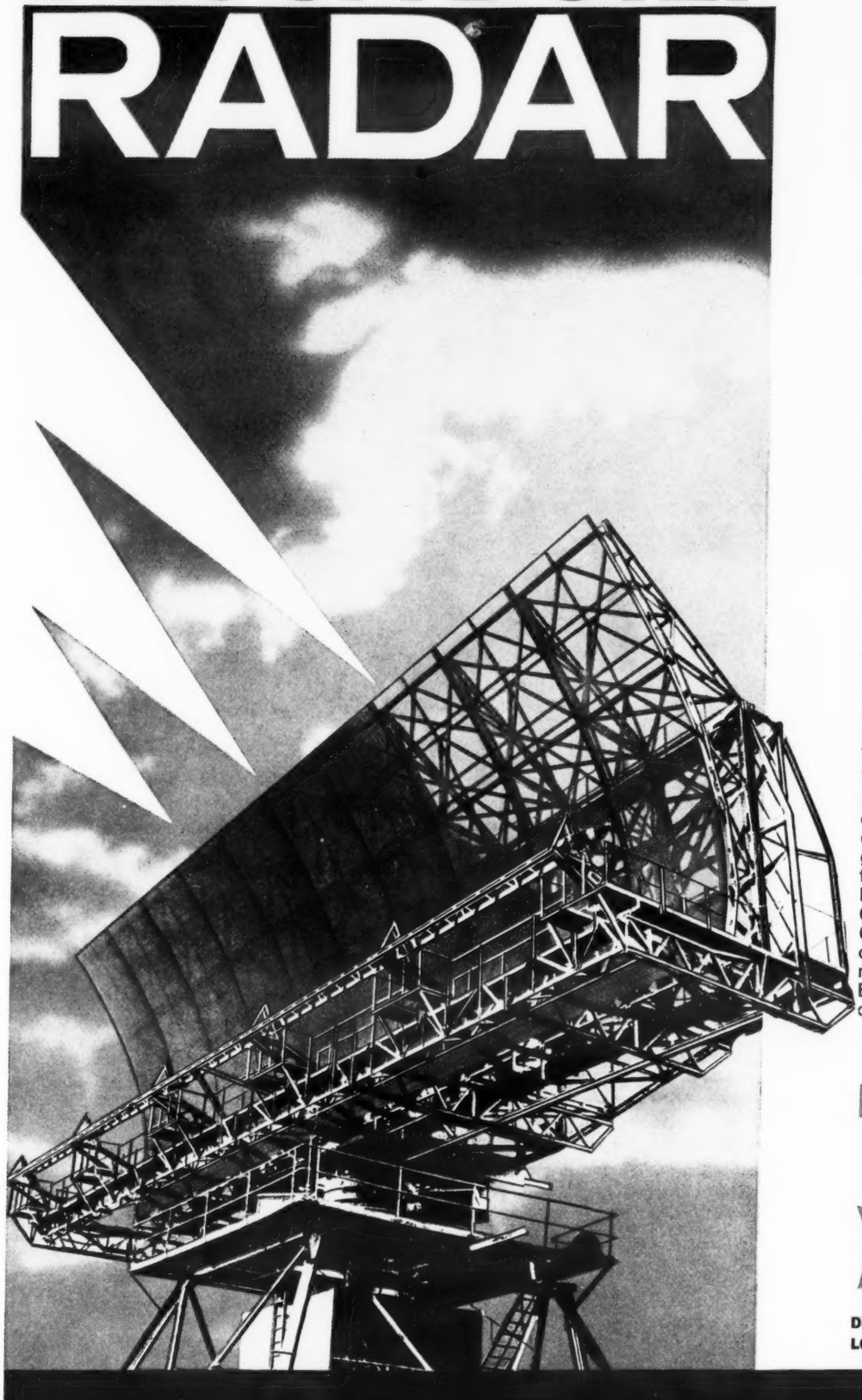
Outside Europe and America

Although they are effective only against piloted aircraft and do not remove the threat presented by the nuclear-warhead ballistic missiles, these means of defence are extremely costly in men and materials. They can therefore be used only to defend economically or strategically vital areas. The United States is installing them on its territory, and Western Europe has agreed to adopt them some day. Formosa has inherited a number of *Nike* batteries. But the future Strategic Army Corps must have a defensive system which is easy to transport and to deploy on the bridgeheads to which its mission of halting enemy expansionism will take it. The Army hopes that the *Hawk* will provide the answer to its problems of mobility and rapid intervention in hostile or neutral territory. A *Hawk* battalion, with three batteries, requires only some 300 men. The whole must be transportable by air and capable of being towed along field tracks or even across country. With such a defensive system the expeditionary corps would be at any rate partially protected against the threat of attack by piloted aircraft. Anyone who has known the anxieties of the early hours of landings and beachheads, when enemy air activity could have destroyed all hopes of success, will regard the *Hawk* system, suitably modified for this kind of warfare, as the decisive weapon.

However, if the enemy also had similar equipment, the advantage would move to his side. It is difficult to imagine how an airborne operation could succeed in an area protected by batteries of missiles similar to the *Hawk*. Once this category of missile is improved, simplified and reduced in weight, it will probably come into general use. If so, will it not preclude the concept of mobility by airlifts and even the employment of piloted aircraft using conventional weapons?

In this case, just as the missile-launching submarine could impose peace between the two super powers, an efficient system of surface-to-air defence missiles could transform the nature of local conflicts: either the belligerents would be obliged to resort to nuclear ballistic missiles, when it would be difficult to localize the conflict; or they would be restricted to subversive war, guerilla warfare, or even political agitation and social unrest. Such would be the big consequences of these small weapons.

DECCA BUILT RADAR



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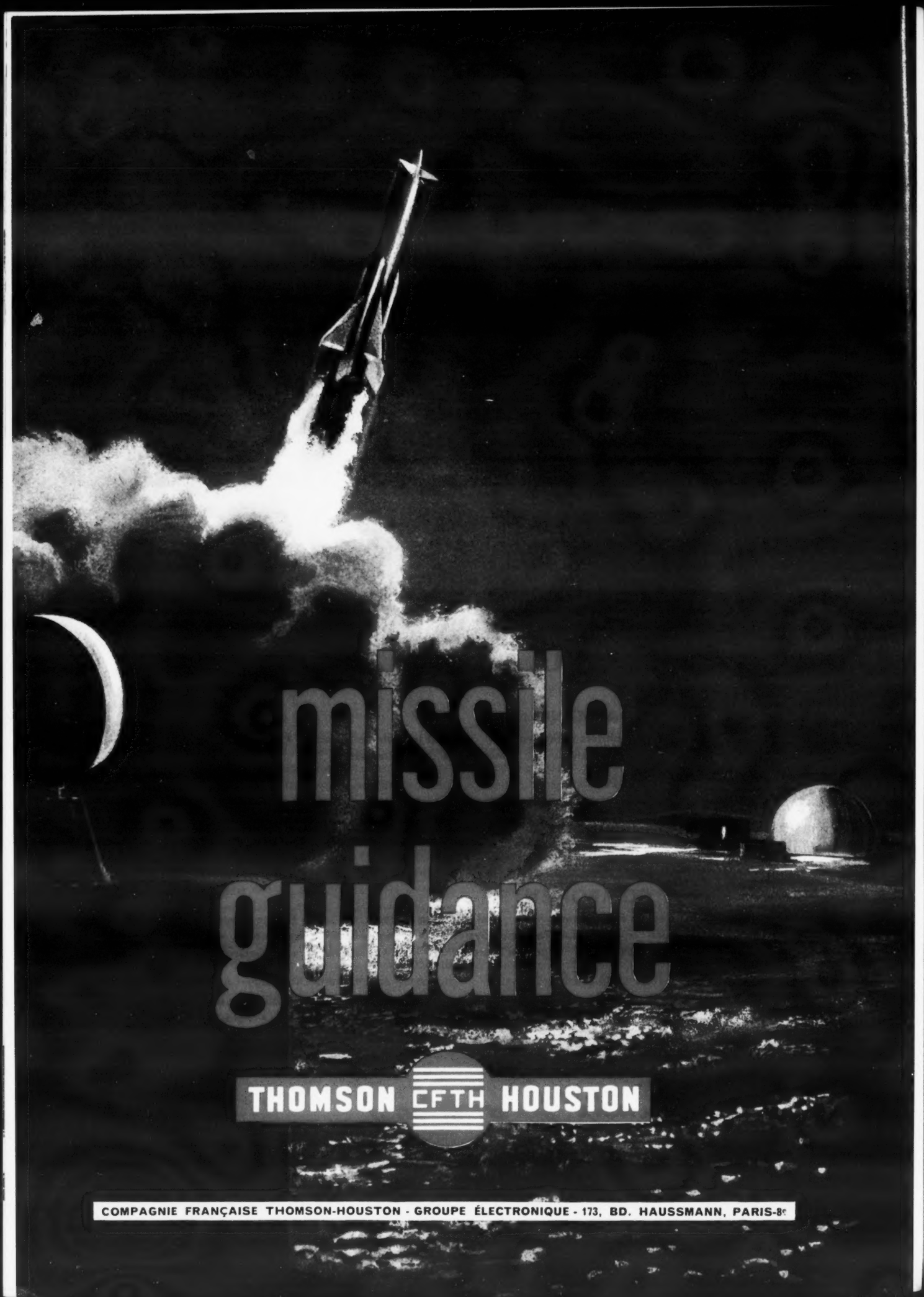
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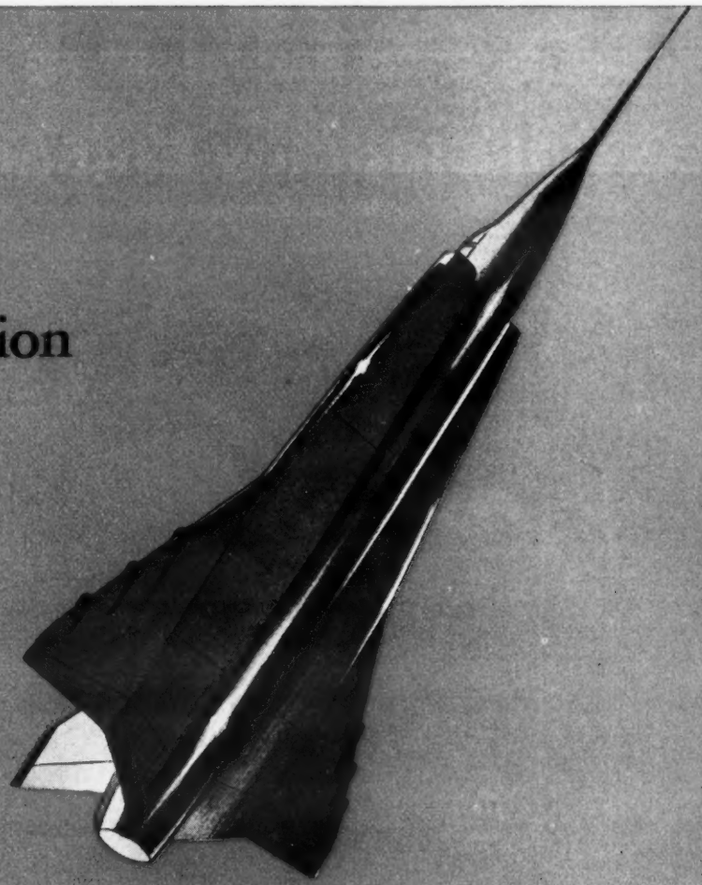
Mach 2 +
for New Draken Version



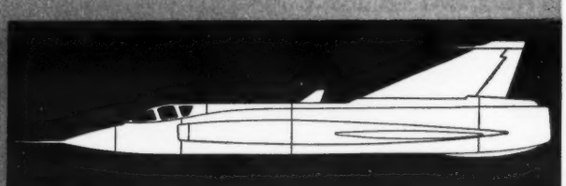
A special new export version of the Saab-35 Draken, single-seat supersonic all weather jet fighter and attack aircraft, has now been revealed. It is powered by a new Rolls-Royce engine of high but undisclosed thrust. This new engine and other refinements will make possible a top speed of Mach 2+, an initial rate of climb of approximately 250 m/sec. (50,000 ft/min), increased service ceiling, and a considerably increased range. This aircraft can also be equipped with heavy ground attack armament.

The Royal Swedish Air Force version of this aircraft will be known as the 35B. Equipped with Saab's new collision-course gunsight and modern air-to-air weapons, the Saab-35B will considerably strengthen Sweden's air defense.

Regarding performance at the lower part of the speed range, it may be mentioned that the Draken, following the successful completion of a two-week trial in Switzerland was decorated with the Swiss Air Force's unique "Hochgebirgsabzeichen" ("Alpine Badge"), which attests that the aircraft can operate from Alpine airfields and manoeuvre in the narrow Alpine valleys in spite of its very high top speed.

The new and important improvements mentioned above will make the Saab-35 Draken an even more efficient weapon. The initial production version of the Draken, the Saab-35A, is now approaching full production and will shortly go into service with the Royal Swedish Air Force.

SAAB



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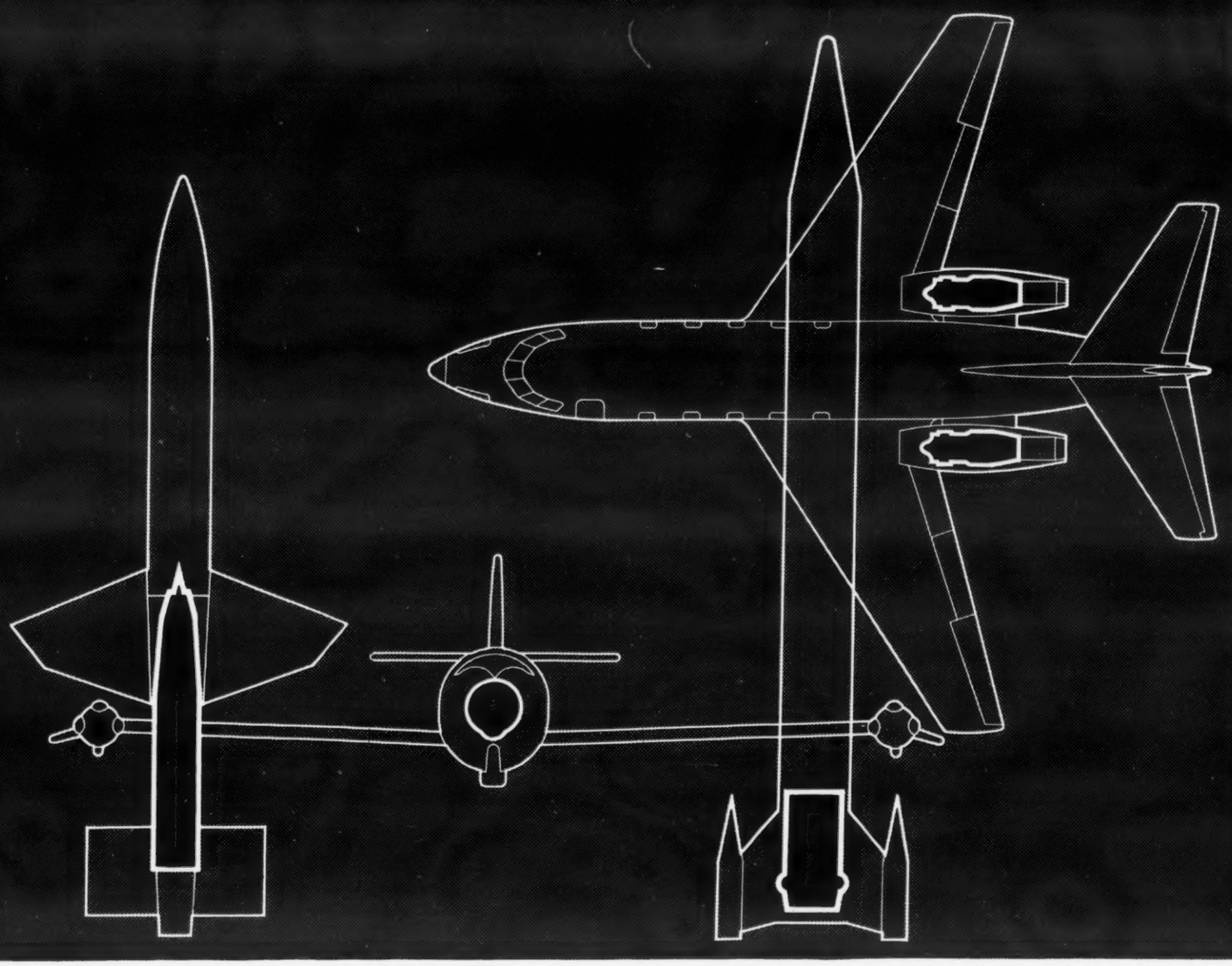

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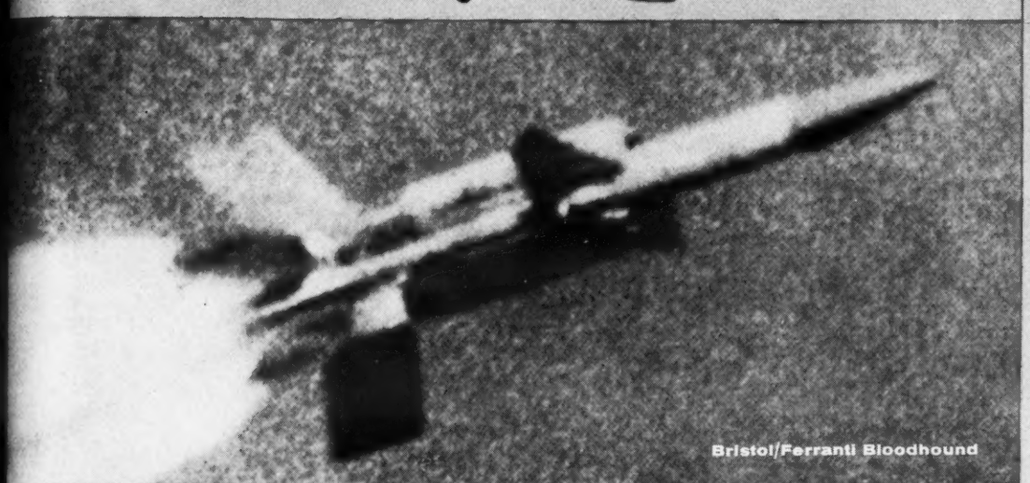
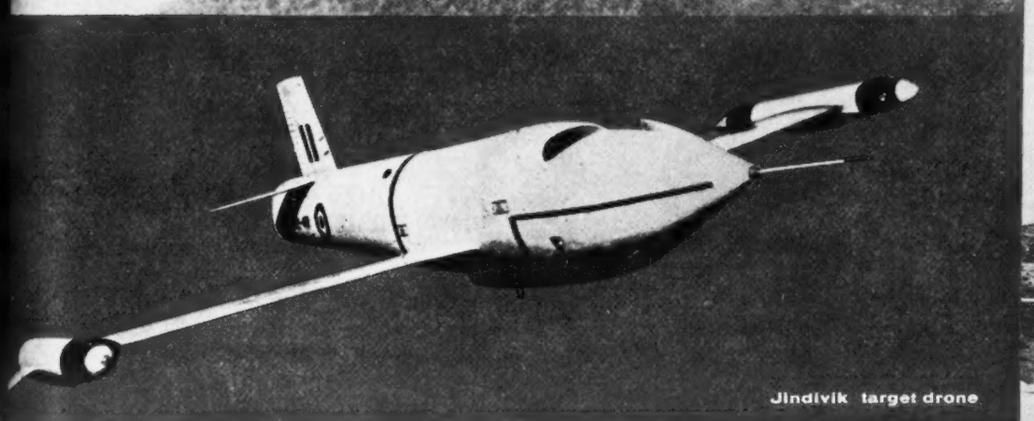
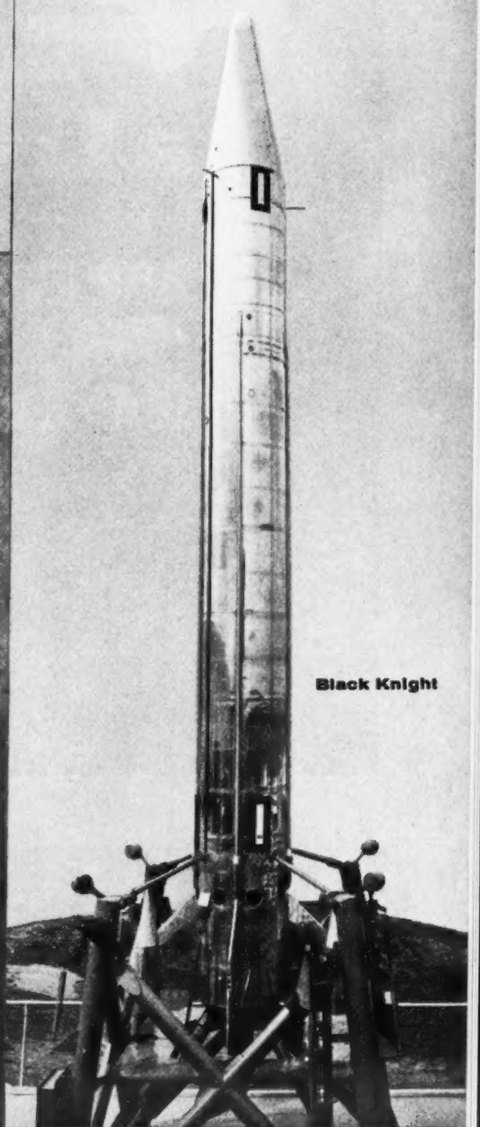


Bristol/Ferranti Bloodhound



Jindivik target drone



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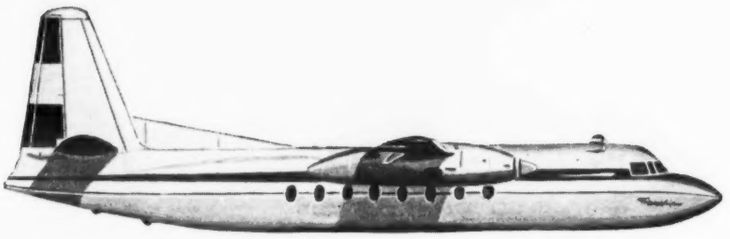

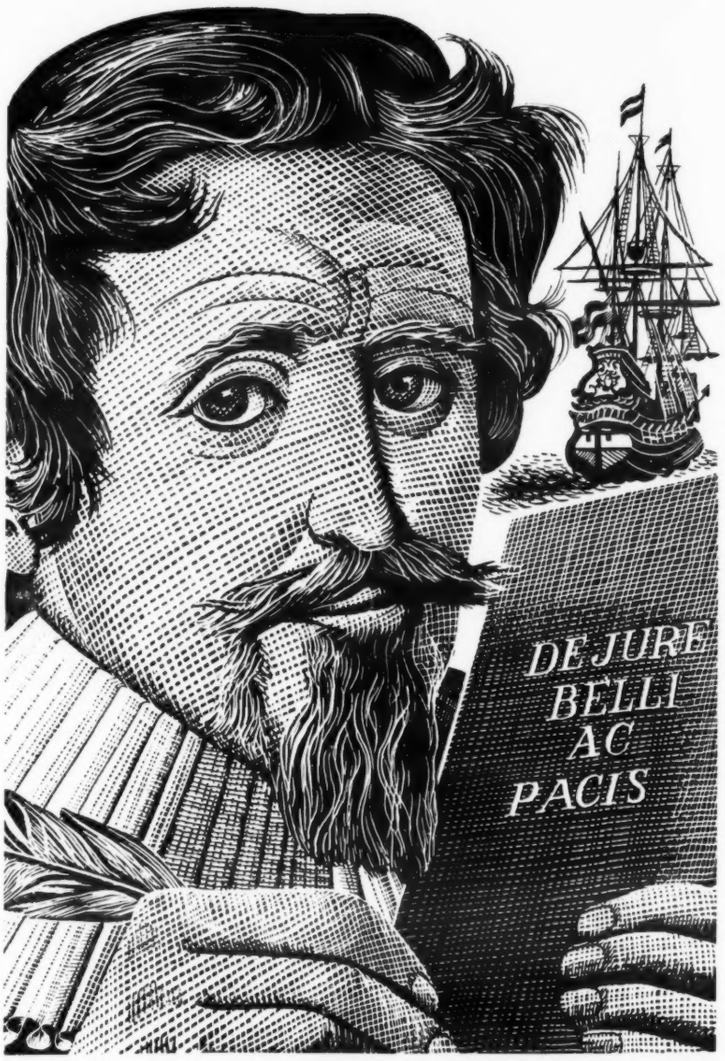

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Low-Altitude Nuclear Strike

A Naval Pilot's Point of View

By Lieutenant Commander K. A. Leppard, R.N., Commanding Officer of 807 Royal Naval Air Squadron

The main aim of any passage and approach to a target is to arrive at a position from which a weapon can be delivered with accuracy and without interference from the enemy en route. The advantages of the low-level transit in achieving surprise and accuracy have long been recognized. However, whilst there is nothing new in the idea of low-altitude strike, the advent of high-speed aircraft with longer ranges than hitherto does introduce new requirements in equipment, training and preparation.

*

The first problem after a long passage over the sea is to achieve an accurate landfall, without which a pilot would be unwise, indeed foolhardy, to penetrate inland. Although the cloud base is not normally a critical factor, provided height is available for visual manœuvre, a reasonable visibility underneath is essential for navigation and delivery. It is no easy matter to fix oneself immediately when arriving at low level and high speed at an unfamiliar coastline, and one cannot wander up and down an enemy coast seeking to establish one's position. An automatic navigation system of great accuracy and not susceptible to jamming would be required to achieve an accurate landfall. Assuming that this system is to be linked to the aircraft compass, greater care must be taken in the swinging of the aircraft compass than has been necessary in the past.

A factor peculiar to carrierborne aircraft is the difficulty in establishing an accurate point of departure to set on the navigational 'black box'. Normally the position of the carrier given at briefing is a forecast, and all carrier aircrew know what changes can be wrought in it by delay on the flight deck, contrary winds and many other variables. If the necessary landfall is to be achieved it is vital that an accurate position should be given to aircrew before take-off, as in states of wireless silence an amended position cannot be passed by radio. Of course, if the landfall were to be made on a coastline in friendly territory, some form of 'lead in' could no doubt be arranged and this would obviate the difficulty.

The second stage of the operation would be the low-level approach to the position of attack. The automatic navigation equipment would undoubtedly be of assistance, but accurate map reading would still be required as a positive check. At very high speed and low altitude, the handling of maps in the cockpit can be a major problem, particularly in a single-seat aircraft. The pilot requires roller-blind presentation near eye level, leaving his hands free to fly the aircraft accurately near the ground and enabling him to map read without putting his head in 'the office'. The roller would have to be geared to turn over at a speed related to the speed of the aircraft and to the appropriate scale. The pilot thus has a minute by minute presentation of his Dead Reckoning position and even if momentarily lost, should soon be able to retrieve the situation.

Adequate preparation has always been a requirement for low-level flying, and if maps are to be cut up to fit roller blinds and a really careful scrutiny made of unfamiliar routes, this factor must be emphasized even more than in the past. The importance of photographs of land-falls, prominent features and aiming points, if possible presented as the pilot will see them, cannot be over-emphasized.

Training for low-level flying at longer ranges presents many problems, particularly in densely populated areas such as the United Kingdom. Many of the areas cleared for low flying can be covered by a *Scimitar*, for instance, in a gentle turn at high speed, and provide little useful training value for the type of flight envisaged. These higher performance types of aircraft would require a route of some hundreds of miles. It is appreciated that this would be impossible to obtain, as the roar of an aircraft arriving devastatingly overhead at high Mach, would be unacceptable to the civilian population, and who could blame them? Many areas over which pilots are liable to fly operationally have not been mapped for some considerable time, and those maps available may not include a large number of man-made features—railways, roads, factories and even towns. Greater emphasis must therefore be laid in training on natural features, i.e. mountain ranges, rivers, plains and lakes. It can be said without exaggeration that the accuracy of this type of attack would depend largely upon the scale and accuracy of the map.

Having successfully penetrated the enemy defences at low level and achieved a measure of surprise, some form of Loft Bombing technique is required to ensure a safe separation between the attacking aircraft and the explosion of the nuclear weapon. If the aircraft were pulled up at high speed in the looping plane, the weapon could be released at such an angle that it would be thrown forward and upwards a considerable distance. The attacker would then have time to recover from the loop by rolling off the top and withdrawing on a reciprocal course to the approach, beyond the lethal range of the explosion.

The problem of knowing exactly when to pull up still remains. Careful selection of a prominent feature on the ground, a known distance from the target, or a range determined by aircraft radar would seem to provide the answer. In the absence of radar, or where no suitable landmark exists near to the target, a pull-up would have to be made on passing directly over the target. The bomb would then be lofted from a near vertical angle, giving little horizontal component of travel. By virtue of the long time of flight of the weapon, a safe get-away, though with less separation, could be made.

The weapon-accuracy in these types of manœuvre would undoubtedly depend upon precise flying and navigation up to the point of release. Here, excessive turbulence and poor visibility would make release from the optimum position extremely difficult. However, by far the largest single error would be caused by wind. Even small deviations in forecast wind conditions would involve large errors, due to the extremely long time of flight of the missile. On the other hand, these inaccuracies might be acceptable, dependent upon the type of target and yield of the weapon.

*

To sum up it would seem that most of the problems associated with low-level strike and toss bombing could be overcome. A high degree of success could be achieved against a nuclear target, given meticulous planning, up-to-date large-scale maps, adequate photographic cover, accurate meteorological forecasts, realistic training and the necessary navigational aids. A formidable list!

However, with the improvement in enemy defences, the passage of time might compel other methods. For example, the delivery of a 'stand-off' missile from low altitude and high speed has much appeal for planners, always supposing that such a system were an engineering possibility.

A Vickers-Supermarine N.113 *Scimitar* carrier-based low-level strike aircraft landing on the aircraft carrier HMS *Ark Royal*.

Low-level bombing

The New Generation of British Low-Level Strike Aircraft

By Derek H. Wood, Interavia's London Editor

Using the scanty information so far released by the British authorities, Interavia's *London Editor reports below on three brand-new aircraft designs put forward by the British industry, and destined to revolutionize tactical air operations in the coming years. The three are: 1. the Blackburn & General Aircraft NA.39; 2. the Vickers-English Electric TSR.2; 3. the Hawker P.1127. The first aircraft has already been ordered into production on a moderate scale for the Royal Navy, while the second type, destined for the Royal Air Force, is still on the drawing board or at best exists only in model form; however, it is backed by the production potential of three large airframe and engine companies. Type number three is at present being developed as a private venture, though this does not necessarily mean that it will not be ordered in substantial numbers if it proves successful. All three aircraft are designed to fit the new military concept of greater mobility for the ground organization—they operate from aircraft carriers or makeshift landing grounds—and greater suitability for low-level attacks. They are intended not only to take their place among the weapons designed to act as a deterrent to global war, but also to deal rapidly with a local conflict before it can degenerate into a major operation.*

Editors

In every major Western European air exercise in the past ten years, the most difficult targets to track and intercept have been the low-altitude intruders, which come in below radar cover so that the fighter units cannot be warned of their approach in time.

Before the advent of toss-bombing with its associated electronic gear, the intruder was usually a fighter-bomber with standard ground-attack weapons such as the rocket projectile and the 500-lb. bomb. Toss-bombing opened a new era, but brought with it many problems. *The aircraft converted to this role were mainly designed for high-altitude work, and consequently their structures have been severely tried when they have been required to cruise under gusty conditions and to perform in high 'G' manœuvres.*

With surface-to-air and air-to-air weapons beginning to get the measure of the high-altitude bomber, thanks to improved performance and guidance systems, there has been an obvious need for a new type of aircraft designed from the outset for low-altitude precision bombing with either nuclear or conventional weapons.

● NA.39 - the first of a new generation

The first aircraft of this type, the *Blackburn and General Aircraft Company's NA.39*, took to the air on April 30th, 1958. It can truly be called the first of a new generation as it has been designed as a two-seat precision bomber flying at about M=.95, with a tactical radius of over 500 miles, fighter-type strength characteristics, and the ability to get on and off standard Fleet Carriers—which involves an all-up weight of not more than 40,000 lb.

The structure, however, has been built to stand a much higher load, which will naturally mean more range. This could also be utilized to good effect in a non-folding land-based version which is at present arousing interest in NATO, and would seem to meet the new Canadian NATO strike wing requirement.

To develop an aircraft within these limitations, new techniques and a great deal of original research have been necessary. The exceptionally roomy fuselage, which is fully area ruled, accommodates pilot and observer in tandem, a large enclosed weapons bay, full all-weather attack and navigational electronic equipment and two flank-mounted de Havilland *Gyron Junior* turbojets.

The wing, with compound sweep on the leading edge, is obviously of integral construction with sections machined from the solid. Good low-speed characteristics have been ensured by leading and trailing edge "blowing" from the engine compressors. It is also probable that "blowing" could greatly assist low-altitude manœuvre at high speed. The high-set tailplane, apparently of the slab type, may also utilize compressed air circulation.

The de Havilland *Gyron Junior* single-spool gas turbines have an officially released rating of 7,500 lb. but other reports speak of later outputs in the 9,000-10,000 lb. thrust bracket.

Nothing has been released concerning the weapons system, but at a recent demonstration of RAF blind landing techniques, the pilot's push-button control panel carried a bomb switch and showed that track, altitude and manœuvres, etc., could be automatically pre-selected—presumably when target radar showed the correct range. It seems likely that this system will be employed on the NA.39.

The Naval pilot in the NA.39 will obviously have a wide choice of approaches to the target, coming in low down all the way, at high altitude all the way, or changing altitude on a set pattern to confuse the defences. Delivery of the weapon, conventional or atomic, can be by any of several well proven "toss" methods or straight from the bay on a normal run.

Nuclear warheads have steadily decreased in size since the NA.39 basic design was finalized, and the Navy may find themselves with a bonus of weapons bay space. One use for this might be to accommodate air-to-air weapons electronics, while the actual weapons themselves could be fitted on underwing pylons. Thus the NA.39 could very adequately defend itself against enemy interceptors before or after its own attack.

By careful fuselage design and "area ruling", Blackburn has allowed for considerable performance stretch in the future. It is not inconceivable that when the low-level bomber is established, supersonic speeds may be required, in which case higher rated engines and lower thickness/chord ratio wing would adequately meet the case.

The NA.39 is at present unique, and the manufacturers, the Ministry test establishments and the Navy will be able to explore and solve many of the problems associated with low-altitude precision bombing, including structural fatigue, aircrew fatigue, stabilization, navigation and the effects of flies, rain and birds which have hitherto not greatly worried the bomber at 40,000 ft. plus.

Three NA.39s are already flying, and the remainder of the pre-production batch (understood to total twenty) will give full scope for simultaneous trials of all systems. Blackburn is tooling up for full production and reports indicate that the order placed is for fifty.

Thus by 1961-1962, Naval Aviation will at long last have a true carrier-borne precision bomber and will be an atomic force in its own right.

A Blackburn & General Aircraft NA.39 carrier-based low-level strike aircraft in low-speed flight, with air brakes extended (powerplant: two de Havilland *Gyron Juniors*).

● The TSR.2 for tactical support and strike reconnaissance

One of the most important British aircraft industry contracts in recent years—for the development of a supersonic multi-purpose combat aircraft designated TSR.2 to replace the well-known English Electric *Canberra* light jet bomber—was announced in January.

This contract means that the RAF will have a supersonic, both nuclear and conventional, low-altitude weapon system capable of operating in both " hot " and " lukewarm " wars. In addition, the basic airframe will have high supersonic performance at altitude, and will be available for reconnaissance, electronic countermeasures and as an interceptor weapons platform. The Service will therefore get an " all round " shot in the arm, and its employment of manned aircraft in first-line categories is extended indefinitely.

The aircraft arose out of a general operational requirement, No. 339, to which nine firms submitted designs. The Air Ministry, after close study of the projects, decided not for a straightforward follow-on type, but for the highest performance combination which could be foreseen with present technical knowledge. Vital factors in the choice of airframe and engines have been short field performance, the actual weapons system, and built-in stretch which will carry operational life through to the 1970s.

Although, as is to be expected, no official details of the specification have been revealed, it is reasonable to assume that the Service requires speeds up to about M = 2.5 at altitude, and M = 1.5 at low levels. Tactical radius would be about 1,000 miles and operational ceiling well above 60,000 ft.

The RAF has realized that, with stockpiles of small-size nuclear weapons rising, the era of long vulnerable runways is closing. Its aim is understood to be to give first-line combat types STOL or VTOL capabilities by 1970, and it is expected that later versions of the TSR.2 may be VTO, probably using Short SC.1 techniques in the shape of lifting platforms.

In accordance with the Government's policy of industry rationalization, the TSR.2 contract has been awarded jointly to two airframe firms, *Vickers-Armstrongs (Aircraft) Limited* and *English Electric Aviation Limited* ; the former being the main contractor, although all work will be shared on a fifty-fifty basis. The engine will be developed by *Bristol-Siddeley Engines Limited.* [1]

The alliance between Vickers and English Electric, with a combined project team based at Weybridge in Surrey, offers one of the largest aircraft design and production units in the West outside the USA, backed up by the tremendous industrial potential of the two parent companies. Undoubtedly the major part of the practical supersonic experience will be contributed by English Electric, who is already in full-scale production with the *Lightning*. The P.1B *Lightning* has completed well over 1,000 flights, of which nearly all have been supersonic as a matter of routine. In addition, as announced in January, the *Lightning* has achieved Mach 2 as a fully equipped weapons system.

In the low-level role, both firms have a good backlog of knowledge—Vickers with the two *Swift* fighter reconnaissance squadrons in the 2nd Tactical Air Force, and the *Scimitar* on Navy carriers ; and English Electric with the *Canberra*, particularly the B(I)8, which can have LABS (low-altitude bombing system) as standard equipment.

The engine for the TSR.2 involves an unusual compromise between high and low-altitude performance, plus, of course, afterburning and provision for bleed for STOL use. The choice of the Bristol-Siddeley *Olympus* indicates the advanced state of this unit as well as its flexibility, and the TSR.2 requirement may produce new versions which could later be adapted for the civil market. In connection with the TSR.2, an *Olympus* variant known as BE.15R has been reported.

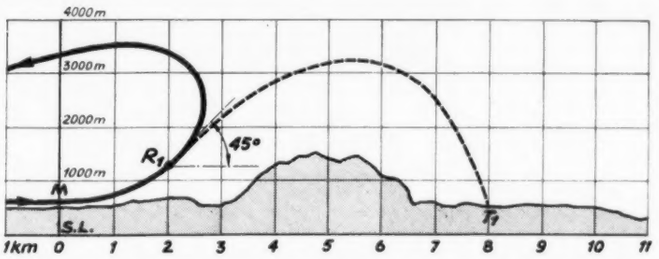
Bristol has currently been running the *Olympus* at over 24,000 lb. thrust using a Bristol-Solar reheat system in which all afterburner outputs are automatically controlled by straightforward pilot throttle movements. The selection of Bristol-Siddeley may also have been connected with STOL/VTOL experience which the Filton factory is obtaining in the development of the lift/thrust powerplant for the Hawker P.1127 light strike aircraft.

● The Hawker P.1127

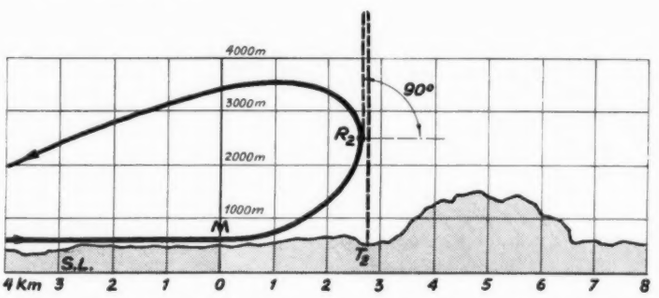
Now in the advanced project stage in the United Kingdom is a very unusual design for a light vertical take-off strike aircraft. Designated the Hawker P.1127, the aircraft would be a logical successor to the *Hunter 6* in the ground attack role and would also appear to fit the NATO stage three close support requirement.

[1] Vickers-Armstrongs (Aircraft) Ltd., with plants at Weybridge, Hurn and South Marston, has a labour force of approximately 18,500; English Electric Aviation Ltd. (plants at Preston and Warton) employs an estimated 11,500 (excluding the guided weapon division); and Bristol-Siddeley Engines Ltd. (plants at Filton, Coventry and Ansty) has approximately 24,000 on its payroll. As the total manufacturing labour force in the aircraft industry is about 200,000, the labour force in the firms behind TSR.2 represents over a quarter of the whole industry.

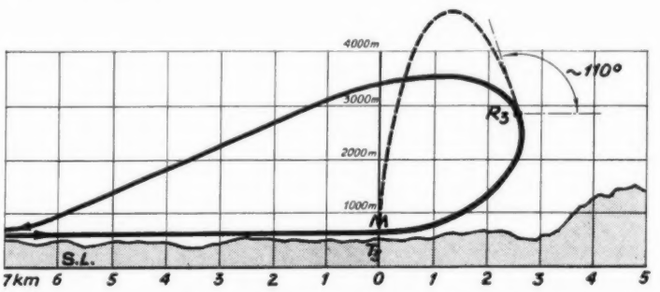
Three methods of toss launching tactical atomic bombs from high-speed low-flying aircraft :



Method 1 (prepared assault) : Starting above an easily recognizable landmark M at an exactly known distance from target T1 (in the drawing 8,000 m), the pilot goes into a half loop followed by a half roll and then makes off without delay on a reciprocal course, in a shallow dive. If the half loop is made with a constant radial acceleration, its radius will be progressively reduced because of the aircraft's diminishing speed and variation in its gravity vector. The bomb is released at point R1 (in the drawing with an initial trajectory angle of 45°) and follows a ballistic trajectory ; by the time it hits the target the aircraft is roughly 13 km away from T1.



Method 2 (prepared assault) : The pilot initiates the same manœuvre over a landmark (in the drawing point M is roughly 2,500 m distant from T2), but launches the bomb directly above the target (at point R2) on to a vertical trajectory. On impact of the bomb the aircraft is about 10 km from T2.



Method 3 (unprepared assault) : Here the manœuvre is initiated directly above the target (M = T3) and the bomb, released at point R3, falls " over the shoulder " (in the drawing at an initial trajectory angle of roughly 110°). At the moment of impact the aircraft is only about 7 km from T3, but is again very close to the ground.

Note : The diagrams are designed solely to illustrate three major methods of toss bombing and are based on approximate calculations. In particular the altitudes reached during the half loop can be considerably greater, or occasionally lower, depending on the aircraft's initial speed and the radial accelerations selected. Automatic control and computing machines are normally used today to carry out the flight manœuvre and release the bomb at the right moment. (*Interavia* drawing).

Little has been released on the project, which is a private venture by the Hawker Siddeley Group, but its main attributes are known to be low gross weight, tough structure, mixed weapon load including bombs, rocket projectiles and air-to-surface missiles and, of course, independence of prepared airfields.

For the structure and general attack requirements, Hawker's Chief Designer, *Sir Sydney Camm*, has a tremendous backlog of experience to call upon, and it is believed that he has combined this with an entirely new type of VTO powerplant.

The engine for the P.1127 is now being built by Bristol-Siddeley with backing from the British and U.S. Governments. It seems that only a single power unit is employed for both forward flight and VTO, probably using a new form of jet deflection. This will result in considerable weight saving as compared with other methods (i.e., VTO engine batteries) and will simplify installation and maintenance. The combined lift/thrust engine might also have future civil applications.

The RAF is known to be very interested in the P.1127 project for ground attack and it would be the lightweight complement to the more sophisticated Vickers–English Electric TSR.2.

Long-Range Fighters and Air-to-Air Missiles for Area Defence

The manned interceptor, whose immediate demise has been repeatedly and loudly predicted during recent years . . . is an unconscionable time a-dying. In fact it appears to have no intention even of abdicating; on the contrary, it has been undergoing a rejuvenation cure to fit it into the changing concepts of air warfare. Though it may be ousted from the airspace in the close defence regions, where the more manœuvrable surface-to-air missile can accomplish the required task more rapidly, it still has a firm foothold in those regions which offer it the necessary freedom of movement: in the airspace above continental regions.

Everything points to the fact that the manned long-range fighter will continue to be the mainstay of area defence during the coming decade. Had they not been convinced of this fact Avro-Canada would not have ventured on the development of the CF-105 *Arrow* (whose fate is to be decided in the course of the present month), nor would North American have tackled the F-108 weapons system. The operational versions of both weapons systems (F-108 with General Electric J93; CF-105 with Orenda *Iroquois*) are designed for maximum combat speeds equivalent to Mach 3 or above, are to operate at altitudes of up to 72,000 ft. and will have ranges in the order of 2,000 nautical miles. Their armament would consist of *long-range* air-to-air missiles with nuclear warheads, while high-performance radar of the latest design would take care of long-distance target detection and tracking.

Air-to-air homing rockets—shown are Raytheon *Sparrow IIIs* carried by a McDonnell F3H-2 *Demon* carrier-borne all-weather interceptor—will continue to be potent air defence weapons. The *Sparrow III* belongs to the U.S. Navy's second generation of operational air-to-air guided missiles, and thanks to its fully active radar homing head, can be fired with greater aiming leaway than earlier air-to-air rockets.

Fitted with two Orenda *Iroquois* reheat jets (instead of the J75s installed at present), the Avro CF-105 *Arrow* could achieve Mach speeds over 3.0, as well as very high altitudes and long ranges. Another design showing the same trend is the North American F-108 weapons system, on which no detailed information has yet been released.

Some hints of the problems facing designers of these weapons systems were given recently by Dr. Allen A. Puckett, Vice-President of the Hughes Aircraft Company and Director of the Systems Development Laboratories.[1] His statements had a particular impact in view of the fact that Hughes Aircraft Company is responsible for the development of the airborne radar and fire control systems for the F-108 interceptor and also produces the GAR-9 long-range nuclear-warhead air-to-air missile.

The lecturer first made it clear that the United States cannot afford to be armed only for one kind of war, e.g., ICBM war. The enemy will always choose the methods which promise the biggest results with the smallest losses. In certain circumstances he might even content himself with dropping leaflets, instead of pushing the ICBM launching button . . . The enemy has at his disposal a complete range of other offensive actions, none of which may justify " total retaliation ". Hence only a *balanced strategy* and *dynamic system planning* can offer adequate protection. Any one-sided, rigid, static defence concept would have exactly the same advantages as the Great Wall of China or the Maginot Line.

The third essential principle, Dr. Puckett added, is *intelligent battle control*. No computer or push-button system can replace human judgment, as the situations arising in wartime never fit exactly into any preconceived pattern based on theoretical considerations. Which of the objects in the airspace are really dangerous enemies and which are merely jamming aircraft or decoys? How strong is the enemy and what are his presumable intentions? What are the best weapons to use against him? These are only some of the critical questions which only the human brain can and must answer.

Theoretically speaking, of course, it is quite possible to leave the human defender on the ground, as is already the case in today's short-range missiles. But if he is put into a well equipped " flying control post ", he will be in an incomparably better position to fulfil his task, Dr. Puckett maintains. And he lists the following reasons:

1. The *high-performance airborne radar equipments* now being developed enable targets to be detected over very long ranges and—unlike ground radars—are also effective *against low-flying aircraft*.

2. If the *early warning information* is doubtful or incomplete, the pilot of a long-range fighter can supplement it with the *means aboard his aircraft*, by hurrying towards or pursuing the object reported, if necessary over very great distances.

3. The manned fighter and its long-range air-to-air missiles enable the enemy to be intercepted far away from his probable target. They thus permit of *air defence in depth*.

4. Technical progress in air-to-air missiles will enable these weapons to be used *against both high-flying and low-flying targets*, without its being necessary for the fighter to leave its optimum combat altitude—which in view of the higher cruising Mach number has been raised well into the stratosphere. The next generation of homing missiles will have such high range and manœuvrability that the carrier aircraft will have far greater tolerances in selecting its attack position.

Flexibility, ability to operate effectively in unpredictable situations, and air defence in depth are, in Dr. Puckett's view, the main advantages of the long-range fighter armed with missiles and equipped with high-performance radar. However, it is freely admitted that tremendous development work is still required on this fighter of the future: transition from airframe manufacturing techniques for Mach 2 to those for Mach 3, with all the consequent problems, in particular in the field of cooling and metallurgy; highly efficient airborne radar and navigation equipment; finally better long-range homing missiles with and without nuclear warheads.

[1] " Considerations of Future Air Defense ", lecture read to interceptor pilots and staff officers of the USAF's Air Defense Command, at Tyndall AFB, Florida, November 1958.

Is There an Answer to the Low-Flying Bomber?

By S.C. Dunn, M. Sc. (Eng.) Guided Weapons Division, English Electric Aviation Ltd.

Ever since aircraft have been used offensively, the kind of defence adopted has changed in sympathy with the speed of attack. For a considerable time both fighter aircraft and anti-aircraft guns were sensible replies to the bomber. As heights and speeds increased, electronic aids were invoked to alert fighters earlier and to better purpose. At the same time guns were supported by radar, computing devices and proximity fuses built into rounds.

During this period the enemy naturally became aware of the probing radio beams which greeted his arrival and sought a loophole in the defence system. At the great heights which were formerly his refuge from physical retaliation he was now a conspicuous object. The obvious course was to approach by that path which was least illuminated by radar. The diffuse beams with which the early designers had to be content could not be laid very close to the surface of the earth before reflections gave trouble. Far more energy was returned by the landscape or by the rough surface of the sea than by the incomparably more minute area of the target, and the latter could escape detection. Even with the very narrow search beams possible today the increase in detection range would be countered by the greater approach speed of the target.

Persuading the target to give warning of its presence is only half the battle, for it still has to be engaged. A gun defence system is hard put to it either to make the necessary predictions accurately enough in the very short time available or, having done so, to explode a shell near enough to the target, because of variations in ballistics. A scrambled fighter defence finds itself involved in closing speeds which prove too great for the unaided human judgment. If automatically guided weapons are considered the only feasible armament, then it is quite wrong to launch the firing platform together with the missile if the latter can be delivered from the ground in the first place.

The beam-riding missile

The radar which continuously observes an aircraft for gun-laying establishes a target sight-line whose accuracy depends on the narrowness of the beam. With a fixed angular uncertainty, the lateral uncertainty in target position increases with range. Hence if the target is to be engaged at extreme distances by a weapon launched along the illuminating beam, the course corrections fed to the missile will include disturbing fluctuations. This is unsatisfactory since the missile is unable to benefit from its increasing proximity to the target, but has to put up with the remote view taken at the radar site. *Figure 1* shows the large miss-distance which could result from the missile and target occupying extreme positions in the beam.

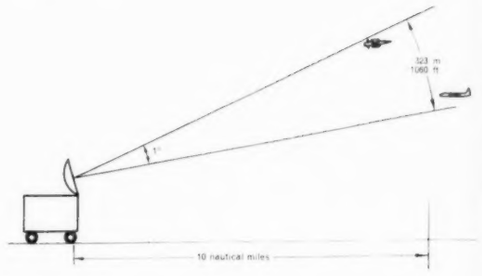


Fig. 1: In a beam-riding system the missile and target cannot be put closer together than the width of the beam at the range of engagement will allow. With quite narrow beams the inaccuracy at even moderate ranges (e.g., 10 nautical miles) is not acceptable.

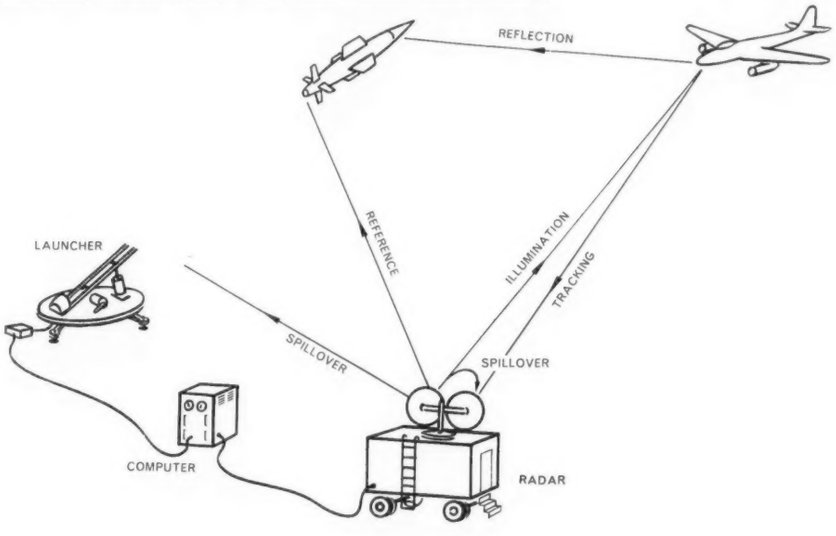
The semi-active principle

A fairly obvious way of improving the chance of collision with the target is to install a receiver in the missile. The information on target heading is then obtained direct from the actual position of the target, subject only to the acuity of the missile's vision. The uncertainty in missile position now decreases as the missile nears it. The latter is no longer constrained to keep within the pencil beam illuminating the target, and its trajectory may therefore be chosen to meet more important aerodynamic requirements.

The target heading seen by the missile is given by an auto-following radar installation which is a miniature version of the tracker receiver in the main radar. Instruments attached to the aerial mounting measure the angle and its rate of turn between the sight-line and the missile axis. By connecting these instruments to the auto-pilot, which actuates the control surfaces, the process of navigation may be made automatic and convergent upon the target.

It should be noted that homing depends on having the missile aerial 'locked' to the target and sensing its subsequent motion. The discrimination and accuracy of the process is a function only of the directive properties of the aerial, assuming the absence of disturbing factors. Although it happens that in order to maintain 'lock' the radar receiver may fasten upon other features of the signal re-radiated from the target, describing its apparent range or velocity, these play no part in the navigation.

Fig. 2: Diagram of a semi-active surface-to-air weapon system using velocity discrimination. The missile compares the frequencies of the original radiation and the target-scattered signal in a semi-active system. The blinding effects of stray radiation (spillover) may make lock-after-launch necessary.



Nevertheless one kind of radar may be preferred to another because it guarantees lock under a wider variety of conditions. When radar was first considered for guided weapons it was natural to exploit the pulse-radar technology existing at that time. The central problem in the design of a radar system is to distinguish the object sought from the vastly greater background.

In a pulse-radar the means of selection is on a basis of range, and all objects at the same range lying within the beam at any instant contribute to the total returned signal. An aircraft keeping close to the ground reflects an amount of energy which is small compared to the total area illuminated at the same instant.

Although the aircraft is protected by the existence of a confusing background of reflections, it differs from this background in moving in a rapid, purposeful way. This deliberate motion may be detected in the signal reflected from the target, since it partakes of the latter's speed by being at a higher frequency than the illuminating beam, or the return from the background. This is, of course, the well-known Doppler effect which is already put to good use in modern navigation systems for aircraft, such as that developed by Marconi.

By using a highly selective receiver, this subtle distinction in the reflection from the aircraft may be revealed, although the intensity of the signal may be quite small, just as the human ear can detect a discordant note among a welter of sound.

Figure 2 shows a suitable arrangement of equipment for a weapon system using velocity discrimination. The illuminator sends out continuously a narrow beam of high-frequency waves from a large circular radiator. A similar structure picks up the return from the aircraft, enabling the transmitter to keep pointing at the target. The missile is mounted on a rotatable launcher. A computer accepts positioning signals from the illuminator, corrects them for the parallax error due to the displacement between it and the launcher, and points the launcher in the appropriate direction. After the missile has been launched, the characteristic return from the moving target can only be isolated if a sample of the original radiation is available for comparison. A small aerial fitted at the rear of the missile picks up a signal broadcast for this purpose from the illuminator. The receiver in the missile compares the signals from its front and rear aerials and filters out the component due to the target.

The effects of jamming

Low-flying is a tactical countermeasure. Electronic countermeasures may also be used. The most obvious of these is noise jamming either by the attacking or by supporting aircraft. In carrying its own jammer an aircraft runs the grave risk of advertising its presence while attempting to confuse the missile. But, as we have seen, the homing principle does not depend fundamentally on the character of the returned signal and a sufficiently broad-minded receiver will be just as happy to steer the missile by the raucous jammer as by the clearer radiation scattered by the structure of the target.

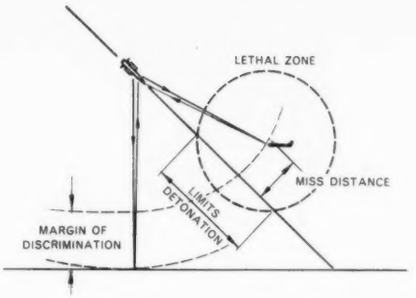


Fig. 3: The particular geometry of the end-course against low-level targets favours the possible use of pulse radar for fusing purposes.

Stand-off jamming, if conducted by a large number of aircraft, cannot be associated with any particular direction and, even if it could, is sufficiently remote in origin to draw a missile to the limit of propulsion. The effect on the missile environment is an increase in background noise for which the only remedy is a corresponding increase in transmitter power. It is one of the additional, attractive, features of a continuous-wave system that it is inherently capable of working at a much higher power level than a pulse system. In the latter, the mean power can only be raised, other things being equal, by increasing operating voltages to impractically high levels.

Clutter

A c. w. transmitter is on all the time. This makes reception in the immediate vicinity very difficult. The conflict between high, radiated and weak, reflected powers can occur in two ways. The primary radiation may leak directly into the receiver (spillover) or by reflection from other objects (clutter). If the transmitter frequency is not very steady or if the 'other objects' include waving vegetation, signals may appear in the tracker receiver masquerading as moving targets.

As far as the level of interference is concerned, the problem is more serious at the illuminator, but spurious signals extend further along the frequency spectrum in the missile receiver during flight because of its own motion towards fixed objects such as clouds, salient terrain, etc.

While the missile is still on the launcher it suffers severely from spillover, and if unfavourably sited or oriented with respect to the illuminator may be so blinded that it cannot see the target. Even so it may be apparent from the tracker receiver response that, once clear of the launcher, the missile should be quite capable of locking to the target. The only solution to this problem is to launch the missile prior to locking at the earliest opportunity.

Fusing

While the launch condition demands a change from pulse to c.w., the final approach to the target again leaves the question open. It will be recalled that the homing process puts the missile on a collision course with the target but need make no use of the additional information contained in the reflected signal. To destroy it, the missile warhead must explode within a certain distance of the target. For this purpose a fairly accurate measurement of range is needed. *Figure 3* shows the last stage of the engagement. For simplicity, the target has been brought to rest. This does not imply any loss of accuracy in the diagram since all the other relevant quantities can be adjusted to give the correct relative values. It will be seen that the reflection from the target can be isolated from the ground returns on a basis of time only.

Mobility

Low-flying is a hazardous business. Coupled with high speeds and heavy loads it is also very expensive in fuel. Used tactically it is effective but without the element of surprise it soon becomes less useful.

Changes in the pattern of warfare evident in this century emphasise the often crucial importance of highly-adaptable, well-equipped, transportable forces capable of undertaking punitive expeditions at very short notice. Once such units have penetrated inland they are extremely vulnerable to low-level air attack.

It is therefore essential that any answer to this threat is sufficiently mobile to meet rapid changes in the focus and direction of attack.

Conclusion

The best answer to the low-flying bomber, apart from the more obvious measures such as radar-camouflaged barrage-balloons guarding vulnerable points, is a semi-active homing weapon guided by high-power continuous-wave radar. If the various major components such as launcher, fire-control post, radar and power supplies are designed as rugged vehicles, the best advantage is taken of the fact that a rocket-propelled craft can take off at the shortest notice from the most hastily prepared site.

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24. Champion Sky-Trac
25. Davis DA-1

HELICOPTERS, VTOL/STOL

26. Ryan Vertiplane
27. Piasecki VZ-8
28. Brantly HO-3
29. Bell HU-1 Iroquois
30. Bell 47J Ranger
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42. Hiller H-23D Raven
43. Robertson VTOL
44. Kaman H-43B
45. Vertol 107
46. Vertol Tilt Wing

FOREIGN

47. Piaggio P-166 (Italy)
48. Piaggio P-149 (Italy)
49. Miles HDM-106 (Gr. Britain)
50. Piaggio P-148 (Italy)
51. Bolkow-Klemm KL-107 (Germany)
52. Pilatus P-3 (Switz)
53. Kawasaki KAL-1 (Japan)
54. Saab 91 Safir (Sweden)
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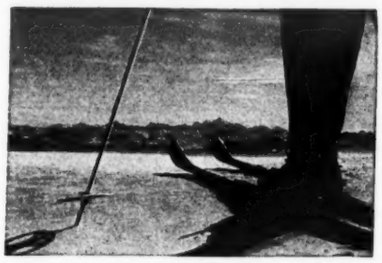
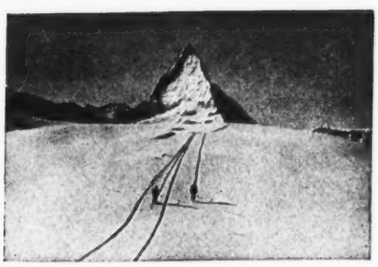
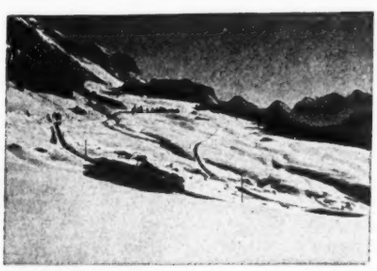


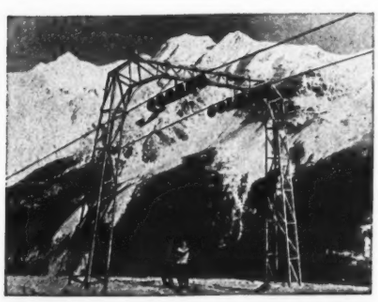
Oh boy ! What a view on the Mont-Blanc (highest peak in Europe) and the French Alps. Shot from the Swiss Jura.



Can you imagine how happy these two people feel ? The " Suger cake " is the Matterhorn (Alpes valaisannes).



On the sunny side of good old Earth. This train will take you right into the heart of the Jungfrau (Bernese Oberland).



And here is the way to climb a mountain without getting tired. In front of the majestic Mont-Blanc, French Savoy.

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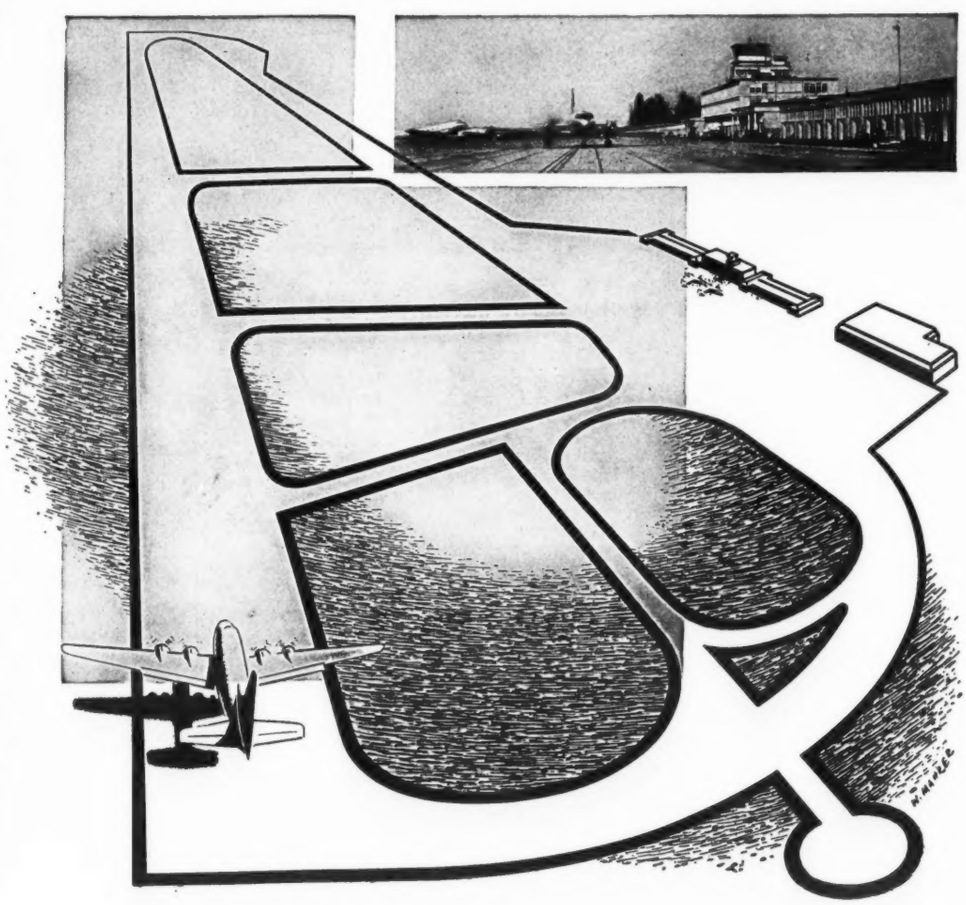

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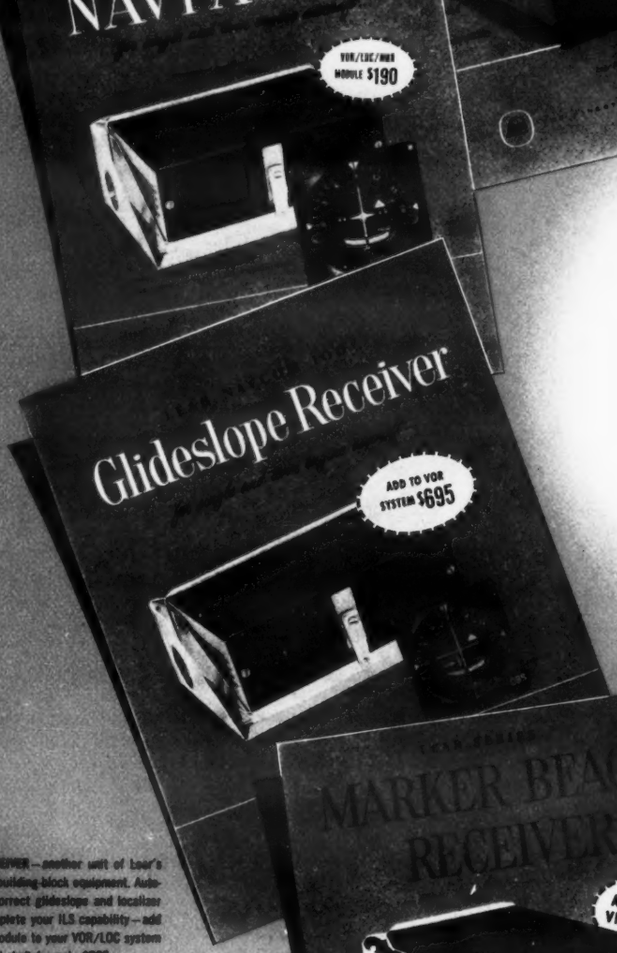

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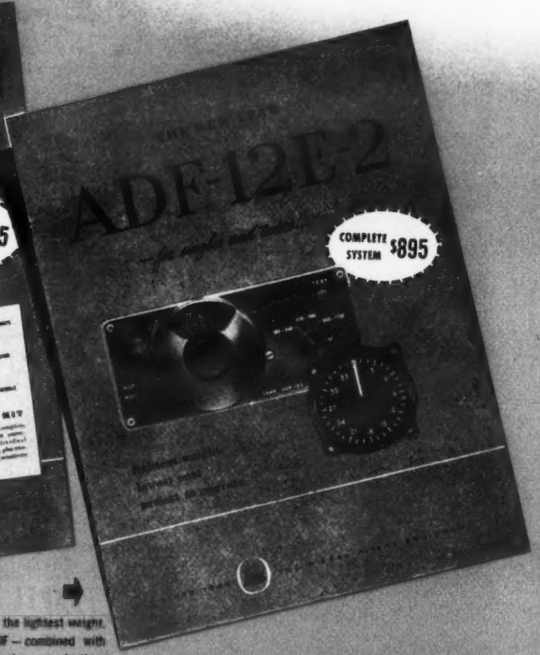

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LC-58

New Tasks for the USAF's Tactical Air Command

The RF-101A photographic reconnaissance aircraft.

At the USAF Tactical Fighter Weapons Meet at Nellis AFB, Nevada, in October 1958, Air Force pilots flying Tactical Air Command (TAC) supersonic aircraft revealed new attack methods with nuclear weapons. They demonstrated various methods of toss bombing, and proved that high-power nuclear weapons can be steered with great precision against enemy targets even from low altitudes.

This unusual method of dropping bombs gives TAC's high-speed front-line aircraft new capabilities in support of the ground forces and the interdiction of supplies in enemy territory. Even a strategic target at a greater distance can be destroyed by a surprise attack from a single-seat fighter-bomber which has been refuelled in mid-air. The aircraft approaches the target at low altitude and maximum speed, i.e. beneath the enemy's radar cover, in order to deliver its bombs immediately before or over the point of attack. While the atomic weapon continues on a flat or steep trajectory towards the target, the fighter-bomber makes a speedy getaway, and at the time of the explosion is already outside the danger zone.

*

A very dangerous system for his opponent . . . but what aircraft types are suitable for such operations, where the aircraft is subjected to enemy fire and extremely high accelerations? As far as airframe strength is concerned, almost all the fighter-bombers in operation with the USAF are suitable: Republic F-84F, North American F-100C and F-100D, McDonnell F-101C, Lockheed F-104C and Republic F-105B; also the Martin B-57E and Douglas B-66 jet bombers. Moreover, a considerable number of Strategic Air Command six-jet Boeing B-47s have been converted for toss bombing, and have been fitted with strengthened wings. Because of their limited fuel capacity, most fighters are only suitable for operations over short distances, and for the transport of small loads. However, the F-101 and the F-105 are in an exceptional position; thanks to the fact that their high permissible take-off weight enables them to carry auxiliary tanks, these aircraft can operate over ranges of several thousand miles, without in-flight refuelling and carrying a considerable military load. The jet bombers possess sufficient range capability but their speed may not always be high enough to carry out such decisive missions. Most important is that the aircraft should be able to execute quick, precise manœuvres during the attack phase, a feat which can hardly be expected from heavy jet bombers to the extent required.

To return to fighter-bombers, even they are not satisfactory in every respect, as—apart from their transport capacity which is usually limited—they were not originally designed for low-level attack missions, but had to be converted later. Their standard equipment and accessory systems were originally intended for other operational tasks. The first fighter-bomber to comply with TAC's new formula is the Republic F-105, with a weight of nearly 20 tons and designed from the outset for the dropping of nuclear weapons from very low levels, with the associated equipment installed.

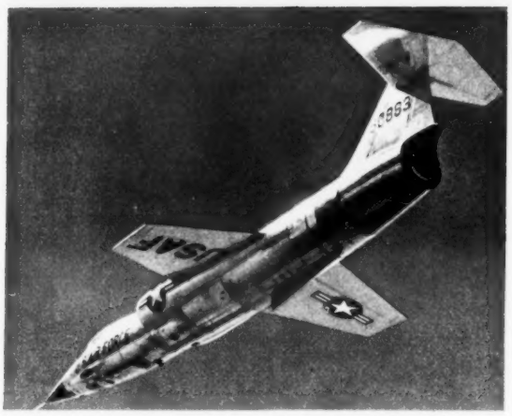
The F-105 *Thunderchief* can look back on six years of development and is now being built in various versions for Tactical Air Command. It also seems to have been decided that a certain number of *Thunderchiefs* will be supplied to European NATO Air Forces. At the end of last year Republic's order backlog for this aircraft had reached $347,000,000. According to the manufacturers, the F-105 is capable of carrying, apart from its standard armament of *Vulcan* cannon (delivering 6,000 rounds a minute), various nuclear weapons and 4,000 pounds of high-explosive and napalm bombs; also a considerable number of unguided rockets and guided missiles; altogether a total of about four tons of bombs and missiles. The weapons bay in the lower fuselage section is longer than that in the World War II B-17.

General Weyland, Commander of TAC, summarized the capabilities of the fighter-bomber as follows: " . . . the new jet can deliver in one strike more firepower than was expended by the entire U.S. Air Force during the Korean War." A complex radar navigation and bomb target system (designated NASARR Monopulse Radar), working with the aid of millimetre waves, permits very accurate bomb dropping both near to the ground and from 50,000 feet, under all weather conditions. NASARR provides not only ground mapping, air search and automatic tracking, but also warns the pilot of ground obstacles. As well as this the F-105 pilot also has a highly sophisticated General Electric flight control system, which relieves him during en route flying, and also fulfils important functions during the attack phase,

The USAF Tactical Fighter Weapons Meet in Nevada: an F-100C dropping practice bombs at low altitude.

Low-Level Bombing

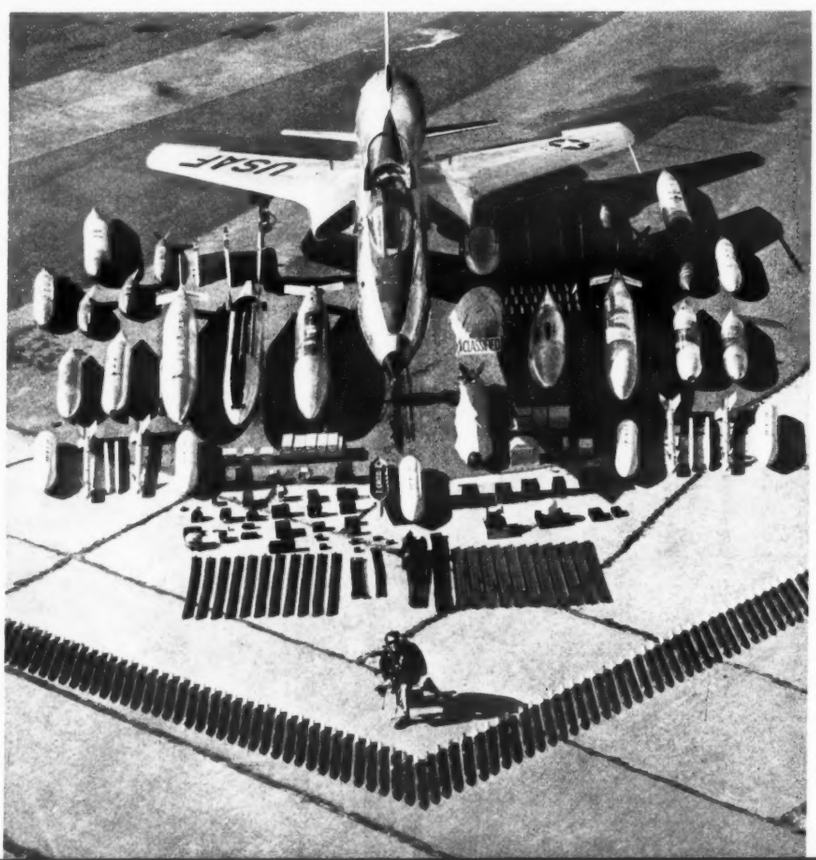
Using the "buddy" refuelling system, the range of the F-105 supersonic fighter-bomber can be increased as required.



The F-104C fighter-bomber can also be refuelled in mid-air: it is now in operation with the TAC Composite Air Strike Forces.

A Martin *Bullpup* radio-controlled supersonic guided missile is loaded into an F-100 D's under-wing weapons carrier.

Military load of the Republic F-105 B fighter-bomber: picture shows, in the foreground, 2.75-in. unguided rockets, a *Vulcan* cannon and ammunition (immediately behind the pilot), and various components of the electronic equipment. Left of the fuselage, first row from left to right: two rocket-ejection containers and two *Sidewinder* air-to-air rockets with launching rails; second row: napalm bomb, container for radar reflection strips ("window"), under-wing fuel tanks for 450 gallons (1,700 litres), containers for the mid-air fuelling system of the buddy tanker aircraft, refuelling tanks; third row: napalm bomb, two 750-lb. bombs (and behind them a flare container), a 1,000-lb. bomb and various bomb carriers. Right of the fuselage, back to front immediately next to the fuselage: practice equipment for the dropping of atomic weapons, and two secret atomic bombs of different configuration; next vertical row, small practice bombs and auxiliary fuel tank for installation in the bomb bay. All other items are duplicates of the weapons shown on the left.



including automatic trimming once the weapons have been released. A Pratt & Whitney J75 jet gives the aircraft near Mach 2 capabilities, and with mid-air refuelling the aircraft can operate to any corner of the globe.

*

Apart from toss bombing TAC has tested other methods of dropping nuclear weapons on the target from low altitudes without danger to the aircraft. The Orlando Division of Martin has developed a relatively simple and light rocket-powered air-to-ground guided missile, designated *Bullpup*, under contract to the U.S. Navy. With a total weight of only 550 lb., the missile can carry a 250-lb. warhead over about 3 miles onto its target, without its being necessary for the mother aircraft to approach closer to the target area. With the aid of radio commands – there is push-button guidance in the cockpit – the pilot can guide the *Bullpup*, flying at approximately Mach 1.8, right onto its target. An improved development of this Naval guided missile is now being built for the USAF's Tactical Air Command, and it is presumed that later versions will be fitted with nuclear warheads.

For these methods of attack, decisive importance is attached to systematic photographic reconnaissance which must extend far into the enemy's rear, to the extent of the range of fighter-bombers such as the F-105B, F-101C and other single-seaters refuelled in mid-air. In the McDonnell RF-101A, originally developed as a high-altitude reconnaissance aircraft for SAC, Tactical Air Command has for some time been operating a versatile supersonic photographic reconnaissance aircraft, with fully automatic camera equipment suitable for aerial reconnaissance near the ground or at high altitudes. At the Tactical Fighter Weapons Meet in Nevada, an RF-101A swept over the spectators at roof-top level and the speed of sound. Barely an hour later the guests were presented with "portrait photos" of themselves, taken from the air. With modern aerial photography, prospects are opening up for tactical warfare such as seemed inconceivable a decade ago.

Quite apart from the *Matador* and *Mace* jet-powered surface-to-surface guided missiles, Tactical Air Command already possesses highly effective attack weapons which could be used against point targets in a major conflict. However, the USAF's low-level attack squadrons would have their most important role to play in coping with local conflicts.

Missiles *and* Aircraft is Sweden's Answer

By a Swedish Correspondent

In the new Swedish air defence organization as outlined in the 1957 Supreme Commander proposal—now approved—guided missiles were to be introduced for air defence at very high altitudes. For defence at medium and low altitudes manned fighters would continue to be used in the foreseeable future.

The 1958–59 budget provided the Swedish Air Force with funds totalling 1,102,400,000 crowns or approx. 40 percent of Sweden's total defence budget. For the first time the Air Force had got more money than the Army. Of the Air Force budget no less than Cr. 742,000,000 was earmarked for aircraft procurement, etc. This appropriation was made in accordance with the "rolling" long-term aircraft procurement programme for the period 1958–65. This programme calls for procurement estimated to cost a total of approx. Cr. 5,300,000,000. It should be noted, however, that the programme does not include funds for procurement of surface-to-air guided missiles.

For several years there has been an item outside the "aircraft" heading in the Swedish defence budget called "Development etc. of an air defence missile" and several million crowns have been appropriated each year for this weapon, which was originally estimated to cost between 25 and 30 million crowns to develop. Very little has so far been said about this missile except that it is becoming much more expensive to develop than planned. In the 1958–59 budget, however, air defence missiles started to play a substantial role as appropriations rapidly climbed to Cr. 24,200,000. In addition to the direct appropriations, authorization was given for new missile orders to the amount of Cr. 51,000,000. These funds are being used not only to accelerate development of the Swedish missile but also for procurement of foreign missiles. It should be noted in this connection that Swedish "airborne" missiles are procured under the "armament" heading in the aircraft procurement programme. Before very long it became apparent that the foreign missile referred to previously was Britain's Bristol *Bloodhound*. The *Bloodhound* was selected only after very careful examination and evaluation of available foreign missiles in various countries, and the order was placed as the result of the work started late in 1957 by a systems evaluation group within the Air Force, comprising experts from the staffs and technical boards involved. It is interesting to note that Sweden in September 1958 became Great Britain's first guided missile customer—in 1945 Sweden was Great Britain's first jet fighter customer.

The Swedish missile order is for an undisclosed number of *Bloodhound* ramjet-powered missiles. The value of the order is stated to be between 20 and 30 million crowns with delivery starting eighteen months from order. The Swedish order is aimed at solving technical, organizational and training problems in connection with the introduction on a greater scale of medium and short-range air defence missiles. A training unit will be established as soon as the equipment has been delivered. The equipment set-up ordered has been decided on with regard to the training activities, which implies that the ground equipment has been overdimensioned in relation to the number of missiles ordered.

Even though the unit is not primarily intended for operational use, the *Bloodhound* unit, however, means a certain strengthening of Sweden's air defence. It has been found practical that the unit training will be carried out at the Army's anti-aircraft units and it has also been disclosed that the first *Bloodhound* battery will be formed at Norrtälje, north of Stockholm. Later on it was revealed that the Air Force unit at Hägernäs will also be equipped with air defence missiles. Training will, of course, be carried out in close collaboration with the Air Force Commander-in-Chief. The latter will be responsible for the operational and organizational introduction of the missiles in air defence, since the air defence missile system is an integrated part of the air defence system in general. The information used in the sector operations centre is the same for missiles as for the fighter defence system, anti-aircraft artillery and electronic countermeasures. The Air Force will thus be responsible for the operational employment of the missiles, i.e., integrating the operations centres with the missile units.

The Army's part in the *Bloodhound* programme will consist of the activities not directly controlled from the Air Force sector operations centres and is aimed at finding out the right kind of organization for the missile unit itself and how the personnel should be recruited and trained. In order to have the ground organization working in time it will probably be necessary to use personnel from other services as well.

Although there is reason to believe that the problems arising in connection with the introduction of air defence missiles can be solved in collaboration between the Air Force and the Army, a completely integrated air defence must be considered necessary.

No decision has so far been made as to which type of air defence missile should be acquired over a longer period. The main reason for the acquisition of the *Bloodhound* was that Sweden wanted, as soon as possible, something that was operationally useful and permitted an early start of Swedish trials.

Cr. 65,000,000 for air defence missiles in 1959-60

Air defence guided missiles figure even more heavily in the Government's recently submitted 1959–60 defence budget, expected to be approved early in 1959. Pending approval of this budget, the Air Force will get Cr. 1,135,800,000, of which sum Cr. 730,000,000 are for aircraft, etc. The cost of the seven-year aircraft procurement programme is estimated to increase to Cr. 5,645,000,000. In addition to the funds requested for aircraft in fiscal 1959–60, the Air Force air defence missile budget will be increased from Cr. 24,200,000 to 65,000,000, implying very substantial, new orders planned either for the *Bloodhound* or the Swedish missile. In addition to the appropriation mentioned, authorization was originally requested to place new orders for missiles to the amount of Cr. 115,000,000, but so far no detailed proposals have been submitted for lack of time. The Government's proposal in relation to new missile orders will most likely mean a reduction corresponding to the reduction made in the appropriation which was lowered from Cr. 80,000,000 to Cr. 65,000,000. According to official statements, the funds would be used partly for procurement of air defence missiles, partly for general missile research and long-term missile development.

So much for the air defence missiles.

Although considerable emphasis is being placed on missiles, the figures previously given hardly point towards any radical change from manned aircraft to missiles. However, certain reductions in the number of aircraft will be made in the early sixties.

To be exact, the number of fighter squadrons will be reduced by five. This reduction will be compensated for by new and more efficient fighters, new and better radar for early warning and "semi-automatic" fighter control. Furthermore the air defence will be provided with a more efficient base system using many more but simplified airfields. This simplification of the base system has been made possible by the excellent short-field performance of the Saab-35 *Draken* supersonic all-weather fighter. This new fighter in its latest version will have a top speed of Mach 2+, and will shortly go into service. It will also become an even more efficient weapon system through the introduction of modern air-to-air weapons and a new collision-course gun sight developed by Saab.

Another valuable strengthening of the country's air defence is provided by the Saab-32B *Lansen* now being delivered to the Air Force night and all-weather fighter wings. In connection with the introduction of the 32B which is fitted with the powerful Swedish-built Rolls-Royce *Avon Series 200* (RM6) with approx. 15,000 lb. (7,000 kg) thrust including afterburner (of Swedish design), a second Air Force wing is being converted into a night and all-weather fighter unit. In this way the night fighter defence will rely on six instead of the present three night fighter squadrons. Other changes likely to take place in the Air Force are the disbanding of the Barkarby (F8) day fighter wing (now flying J34 *Hunters*) near Stockholm and the Halmstad (F14) attack wing (A32 *Lansen*). The Halmstad wing will, however, move to the base of the Söderhamn (F15) day fighter wing (J29) which will be disbanded as a fighter wing and become an attack wing instead. One fighter squadron of the two wings that will be closed down will, however, be added to the fighter wing at Uppsala (F16/F20) and therefore the overall reduction in the Air Force organization will be limited to five fighter squadrons. The total number of day, night and all-weather fighter squadrons will thus be reduced from 30 to 25, while the total number of combat (fighter, attack, reconnaissance) squadrons will decline from 50 to 45.

A Saab A 32A *Lansen* single-seat strike aircraft releases a type 304 long-range air-to-surface missile.

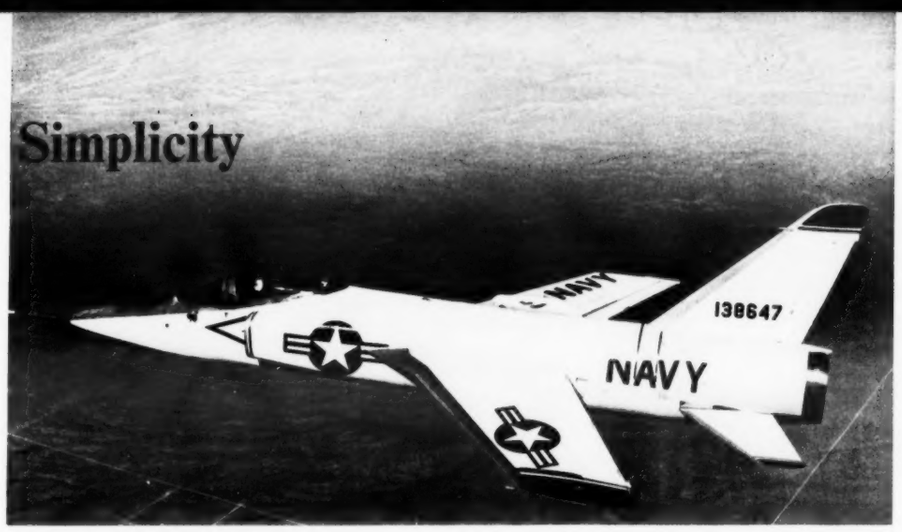
The 12 attack squadrons now fully equipped and trained on the all-weather A32 *Lansen* represent a very substantial force in the country's anti-invasion defence. With the type 304 air-to-surface missiles now in production, the *Lansen* attack squadrons will become even more efficient against surface vessels. The radar equipment used in the *Lansen* has proved to be extremely efficient during recent bad weather exercises, and in the autumn 1958 attack group exercise some 100 *Lansen* aircraft precision bombed towed targets by radar in zero visibility off the island of Gotland.

Considering the increased efficiency resulting from the new manned and unmanned flying equipment and ground radar installations, Sweden believes that it will get a "balanced" air defence. It will certainly require a really serious effort on the part of an aggressor if he wants to be certain of the outcome.

Superiority through Simplicity

Design Details and Production Methods of the Grumman F11F-1F Super Tiger

By Homer U. Tsakis,
Grumman Aircraft Engineering Corporation,
Bethpage, Long Island, N.Y.



The Grumman F11F-1F *Super Tiger*.

The Grumman F11F-1 *Tiger* carrier-borne fighter, forerunner of the faster F11F-1F *Super Tiger*, achieves its excellent all-round performance through application of highly refined, but basically conventional, aerodynamic design*. The Grumman Company's intention of refining the conventional rather than resorting to the revolutionary has resulted in an aircraft which is capable of high supersonic performance without compromise of its low-speed characteristics.

This practice of refining and perfecting the conventional is also reflected in the construction of the *Tiger* and *Super Tiger*. It is a practice which permits construction of the aircraft with readily available tools and materials and without resort to an excess of specialized machine tools and highly trained personnel.

Perhaps the most impressive evidence of the ease with which the aircraft can be tooled up for, and put into production, is the fact that the first *Tiger* aircraft was completed only fourteen months after the contract was issued. That this expediency was not allowed to subordinate the important aircraft characteristics is aptly shown not only by the high performance but by an outstanding service record of durability, strength, and low maintenance time requirements. In fact, during the U.S. Navy fleet introduction program the *Tiger* required only 4.4 maintenance man hours per flight hour.

The basis for the aircraft's ease of production lies in the practice of breaking the aircraft down into a number of major assemblies which can be manufactured remotely from each other. Each of these major assemblies is brought to a virtually complete state before it is assembled to the remainder of the aircraft. This method allows for decentralization of production and elimination of continuous production lines of extreme length.

This aim for simplicity and ease of production is carried through to the sub-assemblies. Every effort has been made to avoid the use of complex forming and machining equipment or unusual processes. On only a few of the aircraft sub-assemblies was it necessary to adopt manufacturing methods which were in any way unique. In these instances it had been determined that the savings in aircraft weight and production time more than justified the adoption of these methods.

The largest single section of the aircraft, the forward fuselage, comprises three major sub-assemblies. These are: the nose section which extends aft to the windshield; the forward section which includes the cockpit, nose-wheel well and duct inlets; and the mid-section which incorporates the ducts, main fuel tank, wing attachment fittings, and the main landing gear attachment points and housings. These sections are constructed in the conventional semi-monocoque practice using ribs, stringers and stressed skin. The massive, forged, full width members which are used in other fighter aircraft are conspicuous by their absence on the *Tiger*. The fittings which carry wing and landing gear loads are relatively small forgings which are integrated with the built-up structure of the bulkheads.

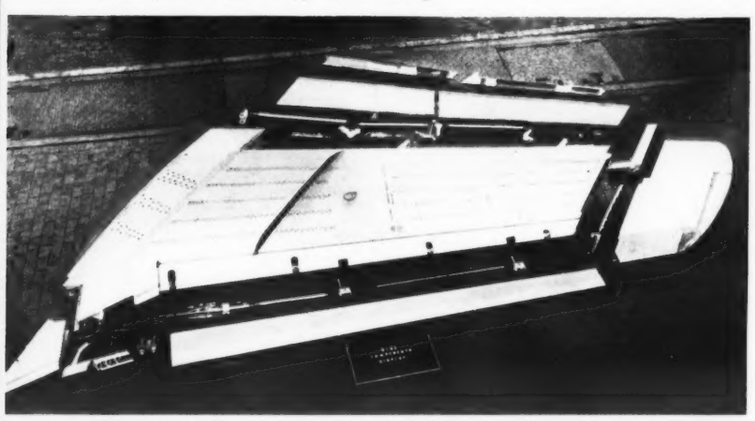
Three of these similarly-constructed bulkheads are placed in a jig fixture and joined to form the wing attachment sub-assembly, using rivets and bolts. The wing attachment sub-assembly is then attached to the aft portion of the mid-section (which had also been separately produced) and the forward portion of this mid-section is built up. The next major structural step is to assemble the nose, cockpit, and mid-sections into one unit, the forward fuselage section. This step is carried out in a joining fixture which accurately aligns the three sections.

The concept of built-up sub-assemblies which characterizes the fuselage construction has been deviated from in the wing construction. In realization of the immense loads to which the wings of a supersonic fighter aircraft are subjected, and in consideration of the importance of weight saving and production time reduction, a relatively new method of construction was utilized. The basis for this new method (which has subsequently been applied to other high performance aircraft) is the machined skin with integral stiffeners.

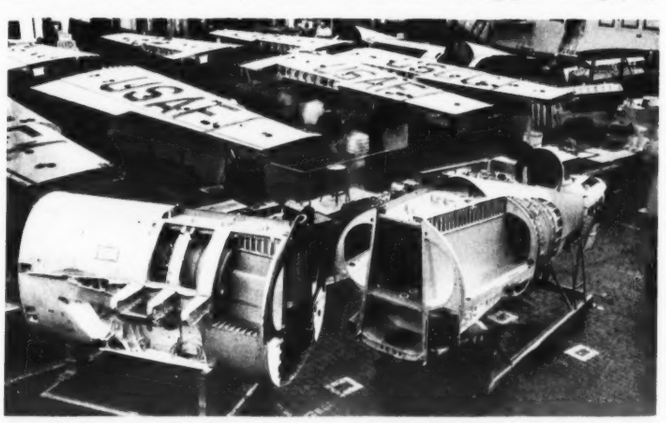
These machined skins are combined with the front beam, intermediate beams, rear beam, intercostal rib trusses, inboard and outboard ribs and the pylon fittings, to form a box-beam structure. The benefits of this machined skin practice are: maximum strength with minimum weight; an airfoil thinness (4–6%) not practically attainable with other construction methods; aerodynamic smoothness with closer contour control; production efficiency through manpower savings; and integral leak-proof construction necessary for utilization of all possible volume for fuel stowage. Production of the machined skins (one upper and

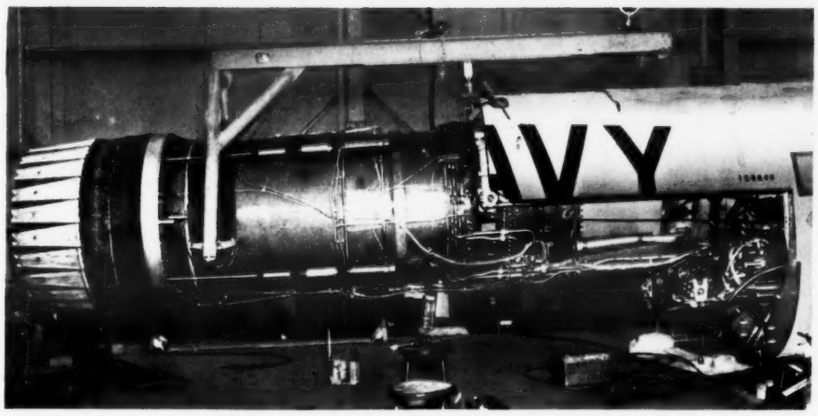
* Cf. "The Grumman F11F-1F *Super Tiger*" in *Interavia* No. 5, 1958, p. 439 etc.

Each wing of the *Super Tiger* consists of a robust, box beam/wing tank, a slat, aileron and flap: also folding outer wing panel (with piano-hinge) for operation on aircraft carriers, and various rods, jacks and fairings.

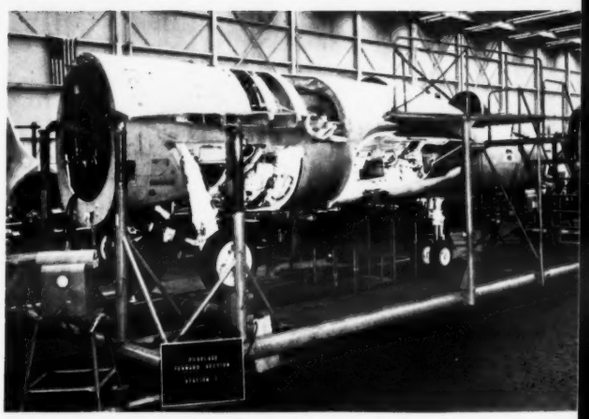


The largest single section, the forward fuselage, has three major sub-assemblies: nose section (not shown here); cockpit section with nose-wheel well and duct inlets (right); and mid-section with air ducts, main fuel tank and main landing gear housings (left).





The tail of the fuselage forward section (cut in the form of a step to facilitate powerplant maintenance) with installed General Electric J79 plus afterburner . . .



. . . and view of the uncompleted fuselage front section looking forward. Simple trestle dollies are sufficient for this assembly stage.

one lower per wing) involves planer-mill type of equipment. Although this machine tool is not in extensive use outside the USA, it is readily available.

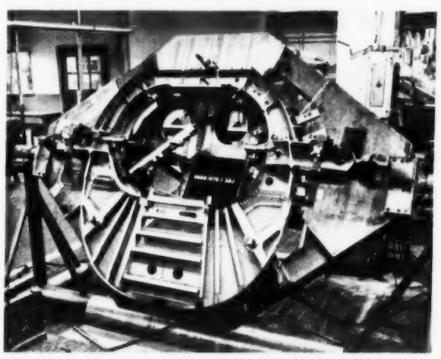
The problem of sealing the integral fuel tanks has been greatly reduced by the use of the machined skins and the subsequent elimination of many seams and fasteners. The seams which do exist in the wing are sealed by a relatively simple, but highly effective, method. This method consists of: routing a groove in the mating surfaces of all structural components which will be wetted by the fuel; injecting sealant into this channel system under pressure through tapped holes in the lower and upper skins; and then plugging of the holes with screws. This method creates an inter-connected fuel-tight seal through the entire tank periphery. After completion of the box beam/wing tank structure it is positioned in a series of staging fixtures for the incorporation of the other wing components.

The tremendous strength which this method of construction imparts to the wing has been verified by evaluation tests during which loads equivalent to 6,000 hours of service life were absorbed without structural failure.

The tail section of the fuselage contains two insulating shrouds, sandwich constructions with the inner and outer skins of extremely thin (.005″—.008″) stainless steel or titanium and the filler of Johns-Manville Thermoflex blanket (½″ thick). The thin material allows forming with simple equipment and fabrication using spot-welding.

Available volume within the tail section is utilized for the storage of fuel. The vertical fin is constructed so as to act as an integral fuel tank

Machined wing skin with integral stiffeners, milled out of thick light-metal plate.



Build-up of one of the three wing bulkheads: the forgings used in the assembly are robust, but at the same time simple and small.

in the same manner as the wings, and the lower forward section contains a bladder type fuel cell.

The main landing gear of the *Super Tiger* has been located so as to take full advantage of the immense strength of the fuselage center section and to leave the aerodynamics of the wing and the fuselage uncompromised. Provisions for mounting the gear are incorporated at the time of construction of the fuselage mid-section. The complete assemblies are installed using only hand tools, while the fuselage section is in the trestle dolly.

While in the trestle dolly the wings of the aircraft are installed. This is again a step which involves the use of only hand tools. The wings are bolted into position, using the holes drilled when the wing and the fuselage mid-section were in their respective jigs, and the quick-disconnect control, electrical and fuel lines hooked up.

After completion of the fuselage forward section with the addition of such minor components as the ejection seat, canopy, instruments, electronic system units, landing gear doors, aerodynamic speed brakes and armament it is removed from the dolly. The completion of the aircraft then necessitates only the installation of the engine and the mounting of the tail section.

A major consideration in the design of the *Tiger* and *Super Tiger*, and the manufacturing methods and production procedures set up for it, was the quantity of production. Had the original F11F aircraft been designed for the large production quantities associated with U.S. Air Force requirements, rather than the relatively limited production for the Navy, the use of complex, costly equipment and processes would have been justified. However, since tooling costs had to be amortized against a smaller number of aircraft, specialized equipment and processes were kept to a minimum.

An additional characteristic of the *Tiger* and *Super Tiger* which makes them attractive to foreign production is the use of conventional materials throughout. The use of stainless steel is limited to the insulating shrouds and several small sections at the aft end of the aircraft.

Some of the intangible problems which arise in the production of an aircraft under license very often concern liaison, coordination, and the transmittal of technical information. The Grumman Company's ability to efficiently contend with these problems is evidenced by the fact that more than 10,000 military aircraft of Grumman design have been built by other companies. Our experience in this field is continuing through the preparations currently being made for production of a version of the *Tiger* in Japan.

It is certain that the *Super Tiger* aircraft is as eminently suited to foreign production as it is uniquely qualified to meet the requirements of the SEATO and NATO Air Forces.

The *Super Tiger* with its impressive weapons arsenal, ready for operation.

What's in the Air?

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SAS hotel and SAS Air Terminal in Copenhagen. The terminal is already in use, and the hotel will be completed in spring 1960. The SAS terminal has a Standard Elektrik Lorenz (Stuttgart) automatic reservations system. The electronic equipment supplies information to agents on free seats on all SAS services for up to 70 days in advance.

Deutsche Lufthansa's new catering building under construction at Frankfurt/Main Airport. The two-storey poured concrete and steel building will be opened in May 1959.

The first Pakistan International Airlines Vickers Viscount 815 *was recently christened "City of Karachi" at Karachi Airport. Left to right: Pakistan's President Mohammed Ayub Khan, Zafarul Ahsan, General Manager of PIA, and Mirza Ahmed Ispahani, Chairman of PIA.*

● **All RAF Valiants** are equipped with Rolls-Royce *Avon RA.28* engines of 10,000 lb. thrust, it has just been revealed. The *Victor B.1* has four Armstrong Siddeley *Sapphire ASSa.7s* of 11,000 lb. thrust each, while the *Victor B.2* is equipped with four Rolls-Royce *Conway RCo.11s* of 17,250 lb.

● **The Brazilian Air Force** intends to fire a research rocket to an altitude of 70 miles in the near future. The development programme for this research vehicle was led by Colonel Manuel dos Santos Lage; construction work was carried out by the military development plant at Marambain (near Rio de Janeiro). Manufacture of the 19-ft. long *Felix I* was carried out chiefly by students working on a voluntary basis, so that cost of construction is estimated at only $1,500. It seems that a live cat will be carried in a special container inside the research vehicle (total weight 875 lb.). After burnout (190 seconds) this container will separate from the rest of the vehicle, and will be recovered by means of a parachute.

● **The Aircraft Division of Short Brothers & Harland Ltd.** announces that it has been developing a close-range surface-to-air missile for shipborne operation. Designated *Seacat*, it will replace the Royal Navy's 40-mm surface-to-air gun which has been the standard weapon for many years. The missile is chiefly designed for the defence of Naval units against low-level air attacks. The *Seacat* is intended in particular as armament on small ships, is small, highly manoeuvrable and powered by a solid-fuel rocket motor with a novel type of guidance system which gives very high promise. Short is also investigating a variant of the missile known as *Tigercat*, intended for use by land forces.

● **The Breguet Naval patrol and anti-submarine aircraft,** intended as equipment for certain NATO units, carries the type designation Br.1150. According to first reports, the aircraft has a take-off weight of 38 tons and is powered by two Rolls-Royce *Tyne* propeller turbines of 5,380 h.p. The following companies are concerned with the development and construction of the Br.1150: Breguet and Sud-Aviation for France, Fokker for Holland, and Dornier for the German Federal Republic.

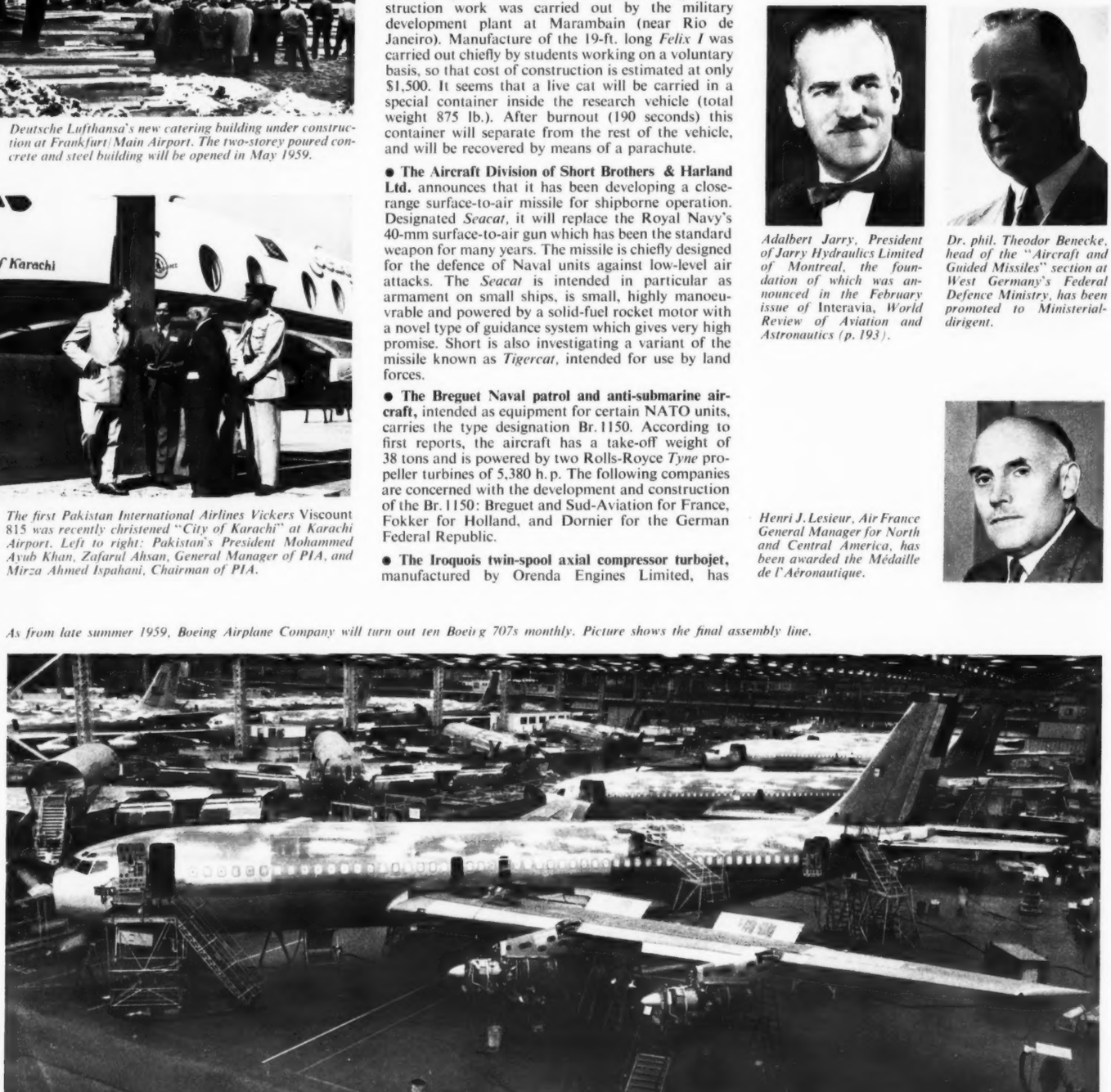
● **The Iroquois twin-spool axial compressor turbojet,** manufactured by Orenda Engines Limited, has

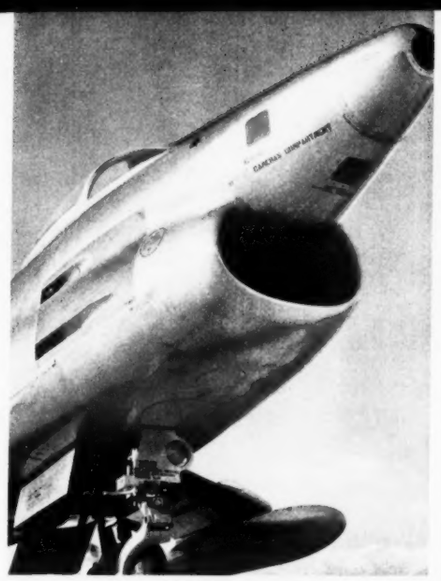
Adalbert Jarry, President of Jarry Hydraulics Limited of Montreal, the foundation of which was announced in the February issue of Interavia, *World Review of Aviation and Astronautics (p. 193).*

Dr. phil. Theodor Benecke, head of the "Aircraft and Guided Missiles" section at West Germany's Federal Defence Ministry, has been promoted to Ministerialdirigent.

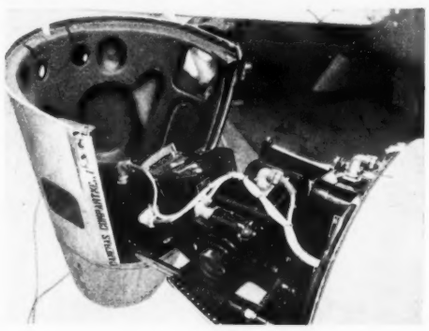
Henri J. Lesieur, Air France General Manager for North and Central America, has been awarded the Médaille de l'Aéronautique.

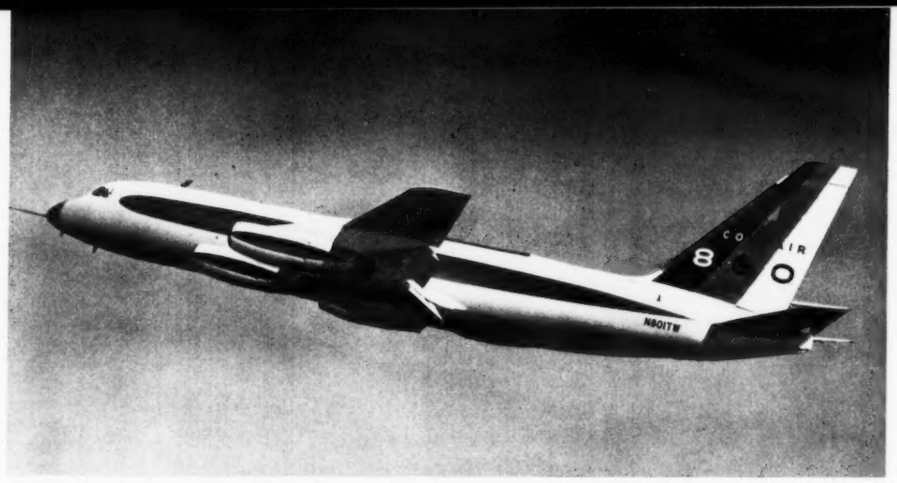
As from late summer 1959, Boeing Airplane Company will turn out ten Boeing 707s monthly. Picture shows the final assembly line.





Close-up photographs of the fuselage nose of the G.91R reconnaissance version of the Fiat G.91 light strike fighter. Operational tests were recently begun on the aircraft, which carries three cameras.





The Convair 880 made its first flight on January 27th.

The Vickers Vanguard, *powered by four Rolls-Royce* Tyne *propeller turbines, made its maiden flight at Vickers' Weybridge airfield on January 20th, 1959.*

10 compression stages and an 8 : 1 compression ratio; annular combustion chamber (32 fuel vaporizers; up-stream fuel injection); three-stage turbine; Lucas-Rotax hydro-mechanical controls; AiResearch starter; Lucas-Rotax fuel pumps; Bendix-Scintilla ignition system; close-coupled afterburner with fully modulated nozzle. Length 231 in. with afterburner and 208 in. without; basic engine diameter 42 in., and diameter of afterburner 47 in.; thrust over 20,000 lb.; weight *(Iroquois 2)* 4,650 lb. including afterburner and nozzle, but excluding starter and firewall.

● **First of three Boeing** jet passenger transports is scheduled for delivery to MATS in late April or May, with two more to follow by the end of the year. Designated VC-137A, the new aircraft will be very similar to the Boeing 707. The aircraft will be used for the transportation of top-ranking government and armed forces officials on overseas flights.

● **A Republic F-105 fighter-bomber** carrying five external fuel tanks flew non-stop from Eielson AFB, Alaska, to Eglin AFB, Florida, in 5 hours 27 minutes; distance 3,850 miles. The F-105 was refuelled in the air during its flight.

● **Hiller Aircraft Corporation's** three-seat 12E helicopter (Lycoming 305-h.p. engine) has been awarded the FAA official Type Certificate. The Hiller 12E has a take-off weight of 2,700 lb., and can transport a useful load of 1,000 lb. Service ceiling is 16,200 ft.; hovering ceiling 9,500 ft.

● **Boeing's Wichita plant** has delivered the last of the B-52F series. Only the B-52G is now still in production.

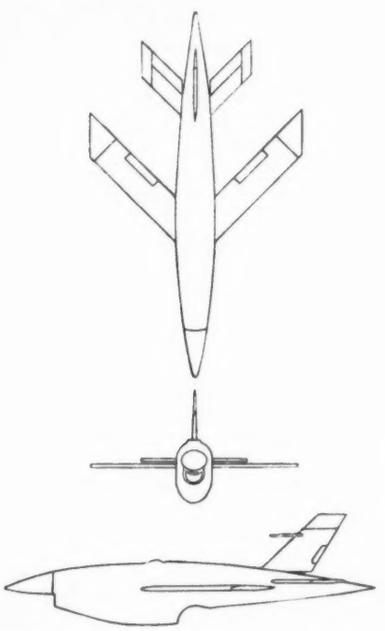
● **The Bristol BE.47** jet engine's thrust class is now officially revealed as 6,000 to 8,000 lb.

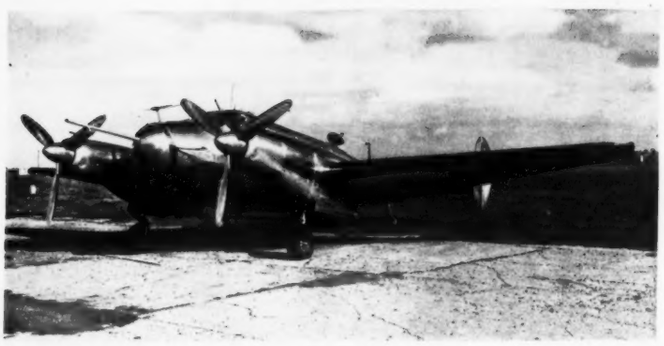
● **The Rolls-Royce Dart RDa.10** propeller turbine has successfully completed a 150-hour type test to the combined U.S./U.K. Civil Type Test Schedule at a dry take-off rating of 2,660 t.e.h.p. (2,400 s.h.p. plus 670 lb.). It is furthermore announced that a *Dart* has completed a 25-hour flight approval test at a military rating of 3,200 s.h.p. boosted with water-methanol.

Type certification tests have been commenced on the three-seat Borgward-Focke Kolibri 1 *helicopter (260-h. p. Lycoming engine). A second prototype is in an advanced stage of construction. The type tests will be completed by March or April this year. Preparations are now being made for production of a first small batch of ten* Kolibri 1s.

Operational tests with France's Alouette II *jet helicopter on board the USS* Everett F. Larson *destroyer.*

A more powerful development (Q-2C) of the Ryan Firebee *jet target drone is being built under a $10 million USAF contract. The Q-2C will have a speed of more than 500 knots and a service ceiling in excess of 9 miles.*





A Beech D.18-S has been fitted with Turboméca Bastan *propeller turbines (700 h. p. plus 165 lb. residual thrust; Ratier-Figeac three-blade v. p. propellers) at France's SFERMA, Suresnes, plant.*

The first of ten Canadair 540s for the RCAF (fitted with Napier Eland *propeller turbines) began flight tests on February 2nd. The RCAF designation of the aircraft will be CC-109.*

Mounting the North American X-15 experimental rocket-powered aircraft under the wing of its Boeing B-52 carrier aircraft involved much preparatory work and research (by the time these lines appear, the first tests will probably have been carried out). For example, tests had to be carried out to determine whether vibrations would set up resonant frequencies between the X-15 and the B-52, causing structural damage or even tearing the rocket plane from its fittings.

● **A number of Hughes YHO-2HU** lightweight helicopters (Model 269A) are at present being tested by the U.S. Army at Fort Rucker, Alabama, and Edwards Air Force Base, California. The YHO-2HU is an improved development of the earlier Model 269. The new version is powered by a 180-h.p. Lycoming O-360-C2B; cruising speed is 65 knots; range approximately 130 nautical miles; rate of climb 1,100 f.p.m.; service ceiling 11,000 feet. Diameter of the main rotor is 24 ft. 10 in.; total length 22 ft. 3 in.; weight equipped 915 lb.; take-off weight 1,150 lb.

● **A Grumman Ag-Cat** recently began an extensive tour including demonstration flights to agricultural groups in Mexico, Guatemala, El Salvador, Honduras, Nicaragua and Costa Rica. Grumman's exclusive foreign sales agent is Smith, Kirkpatrick Co. of New York.

● **The Pirna 014 jet engine** (6,940 lb. thrust; installed in the Type 152) has undergone successful static endurance tests to ICAO standards, according to reports from East Germany. The first model of the Pirna 018 propeller turbine is at present undergoing bench tests.

● **Quantity production of the SEPR 841** rocket engine has been subcontracted by SEPR to Société Hispano Suiza who will manufacture a first batch of 200. The SEPR 841 is installed in the Dassault *Mirage IIIA*. The liquid-propellant engine has a minimum thrust on the ground of 1,650 lb. on one barrel, and a maximum thrust at 52,500 ft. of 3,700 lb. on two barrels. Standard engine change can be made in less than 20 minutes.

● **Pratt & Whitney Aircraft** announces that the JT-12 jet engine has been selected by Lockheed to power the four-engined version of the *JetStar* utility and communications transport. The contract calls for first deliveries of production model JT-12s to begin in October 1960. The JT-12 delivers a static thrust of 3,000 lb. at a weight of only 430 lb. With four Pratt & Whitney JT-12s, the total weight of the *JetStar* in normal configuration (ten passengers, two crew and fuel) is 30,680 lb. At this weight it will take off in only 2,800 ft., and with a normal range of 1,650 nautical miles. With external wing fuel tanks the *JetStar* will weigh 38,000 lb., take off within 4,500 feet and have a range of 2,600 nautical miles.

● **American Airlines'** fleet of ten DC-7B piston-engined transports are to be converted into cargo aircraft at a cost of $4,250,000. The conversion work will be carried out at the Douglas Aircraft Company's Santa Monica, California, plant and the first of the aircraft is scheduled to be ready for service by late summer 1959. To facilitate cargo handling, extra large doors will be installed in the DC-7Bs, and the aircraft structure will be materially strengthened for heavy duty.

A limited amount of special mail was carried on the Convair 880's maiden flight, as shown in the picture. On January 23rd, Lockheed marked the first scheduled flight by the Electra *on the American Airlines Chicago–New York route with a special envelope.*

The Do27 assembly lines at the Dornier plant, Munich-Neuaubing. Centre, assembly; right, mounting of the engine and undercarriage; left background, wing and slat construction.

First 50 years of powered flight in Canada

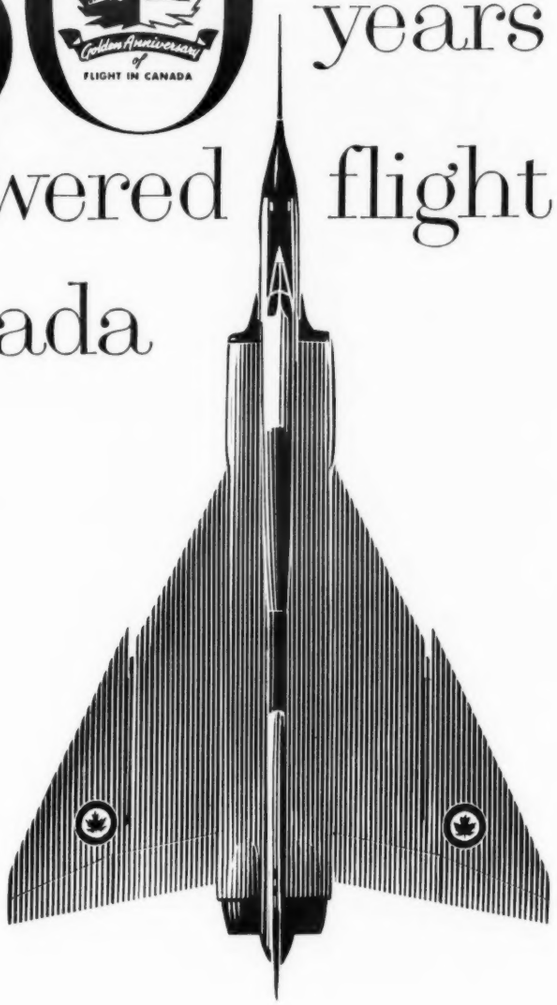
1909 1959

Golden Anniversary of FLIGHT IN CANADA

1909–1959

From the DART in 1909 to the Arrow in 1959 a pattern of aeronautical accomplishment has been dramatically recorded in Canada. The past half century of Canada's growth and increasing stature has been greatly accelerated by the swift and vigorous momentum of the men and machines of the Air Age.

Well established in the Jet Age, Canada's aeronautical resources will continue to meet the urgent requirements of a nation on wings.



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Vertol Aircraft Reports on —

Tandem rotor amphibious

The Vertol 44 is the only amphibious helicopter certified by the CAA for day and night autorotative landings in Sea State 3 (3-5 ft. waves). And it meets or exceeds Navy specifications for waterloads, and stability about all axes. The safety and efficiency of the new flotation system have been proved in more than 1500 autorotative landings, including more than 300 made at night.

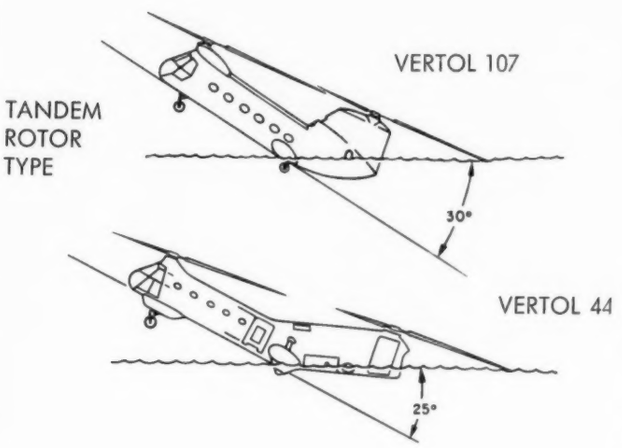
The flotation equipment developed for the amphibious Vertol 44 overcomes excessive drag and weight of earlier systems and, with the tandem rotor configuration, provides these superior advantages :

This amphibious Vertol 44 has made both power and autorotational landings routinely at up to 35 knot forward speed, at a gross weight up to 14,350 pounds.

Float-equipped Vertol 44 floats in the water. Tests at speeds up to 10 knots, have proved that the Vertol 44 control and maneuverability are excellent in water taxiing.

The sealed fuselage and three floats of the Vertol 44 provide excellent buoyancy and stability about all axes.

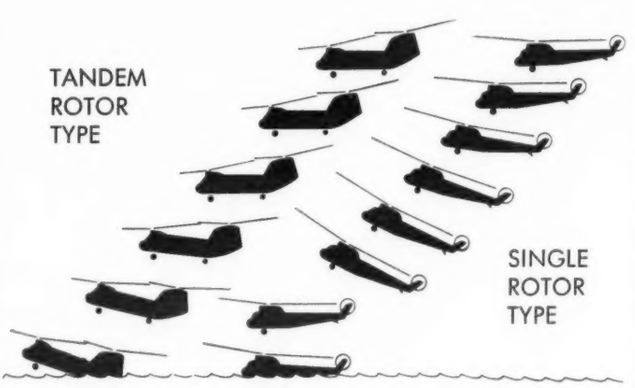
MAXIMUM WATER LANDING ANGLES BEFORE ROTOR BLADE CONTACT



Large clearance between water and rotor on the tandem rotor helicopter permits wide range of longitudinal attitudes in autorotative landings. Records show that landings can be made from longitudinal trim position of 10 to 30 degrees, or a variation of 20 degrees on water contact—several times the angular range possible with a tail rotor.

superiority...

- Light weight, permanently inflated floats
- Minimum aerodynamic drag and download
- No increase in helicopter vibration level
- Ability to "fly" into the water day or night
- Strength for landing at high velocities
- Large rotor clearance, permitting nose-high or level autorotative landings
- Ability to start and stop rotors on water with no yawing
- Good water handling characteristics
- No heavy shaped hull, increasing the weight empty, is required.



The capability of the tandem rotor helicopter to land at high sinking speeds and high nose-up attitudes allows the pilot considerable latitude in flaring the helicopter, without having to judge his precise height over water or change attitude prior to water contact. Pilot of the single lifting rotor helicopter has to be precise in attitude to avoid damage to tail rotor and requires large cyclic control motions.

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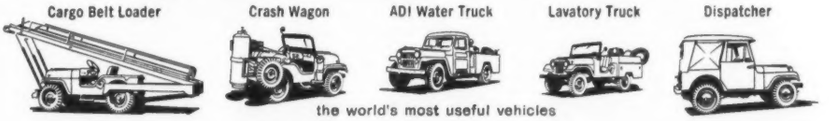


the world's most useful vehicles

NASA Gets off to a Fast Start

The Central U.S. Agency for Aeronautical and Space Research

Nearly half a billion dollars is the total requested by President Eisenhower for his *National Aeronautics and Space Administration* in the budget for fiscal 1960. He has also asked the Congress to grant the new agency a special appropriation of $48,354,000 for the current financial year to be devoted primarily to speeding up " Project Mercury " ($21,000,000) and developing new rocket engines and satellites ($24,000,000). These figures and the space research programme announced by the NASA Administrator for the coming operating year reveal the importance attached to the National Aeronautics and Space Administration in the Great Powers' race for the conquest of space. Only a year ago the NASA project was lying in a drawer at the White House, but today the agency is directing some of the United States' most important research projects. How has this happened ?

Scarcely had Defense Secretary McElroy created the Advanced Research Projects Agency early in 1958, and thus formed an overall organization to coordinate the space projects of all three services, than Eisenhower produced the plan to establish a Federal civil agency for aeronautical and space research. The President not only asked for initial appropriations amounting to $125,000,000 and the transfer of a further $117,000,000 from the 1959 defence budget, but also proposed that NACA, which had been in operation for more than forty years, should be transferred, complete with laboratories and staff, to the new agency. The rest followed inexorably.

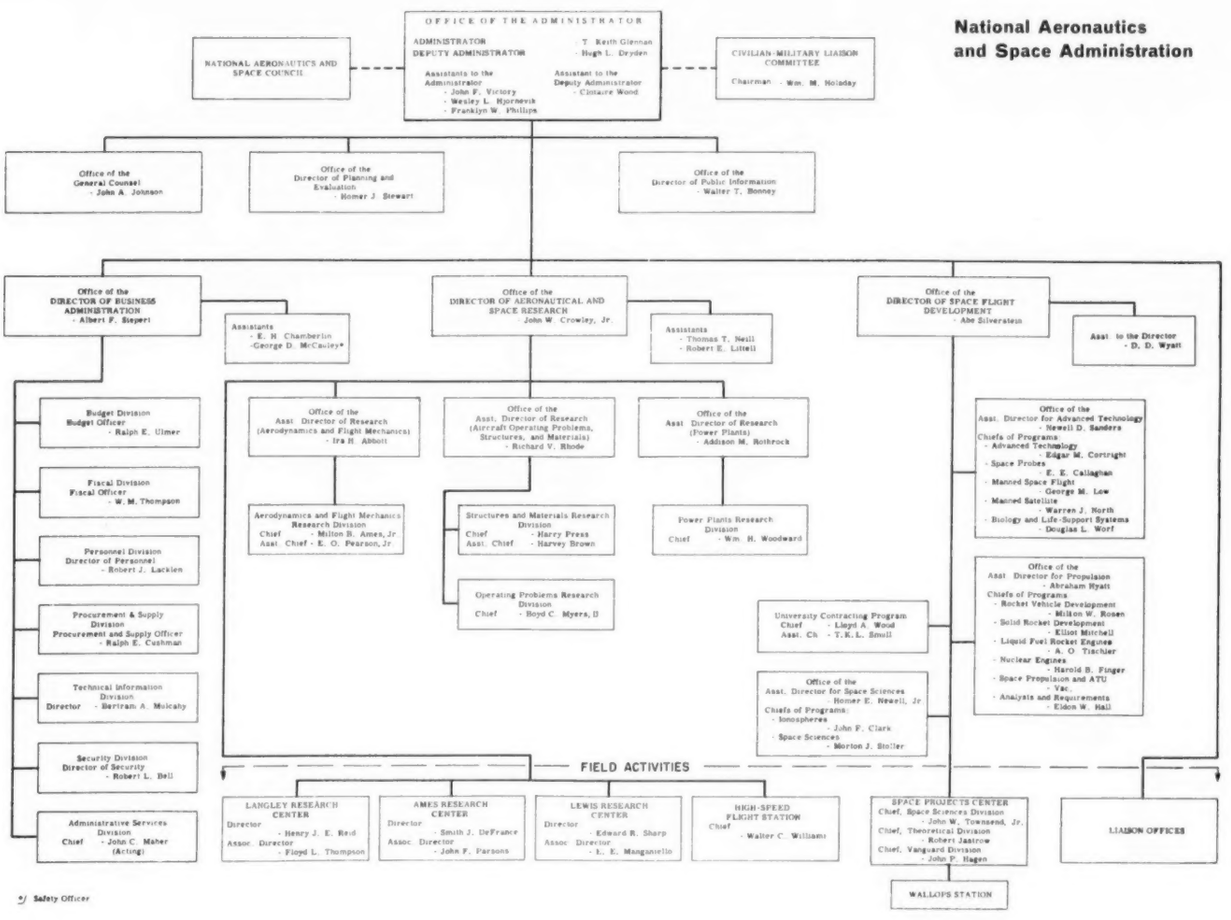
On July 29th, 1959 the President signed legislation setting up the National Aeronautics and Space Administration and outlining its tasks and the responsibilities of its chief. The Administrator is in charge of the planning, directing and conducting of aeronautical and space activities and is directly responsible to the President. The latter is assisted by an eight-man advisory council comprising the Secretaries of State and Defense, the NASA Administrator, the Chairman of the Atomic Energy Commission, one Federal official to be named by the President and three members, also appointed by the President, from the fields of science, education, engineering or public affairs.

The following is a summary of the (previously military) research projects transferred to NASA in the autumn of 1958:

- the U.S. Navy's *Vanguard* earth satellite programme;
- the U.S. Navy's existing *Minitrack* satellite tracking and transmission network and construction of two additional *Minitrack* stations;
- U.S. Army and Air Force lunar probes;
- an Army project for an inflatable balloon satellite;
- additional *Explorer* satellites;
- research work in the field of nuclear rocket engines, and the USAF's *Rover* nuclear rocket engine programme;
- programmes for large fluorine engines;
- a giant rocket engine for a thrust of at least 1,000,000 pounds;
- development of guidance systems for interplanetary research rockets (including ultra-light power supplies for intruments and transmitter), and finally;
- a manned earth satellite and the auxiliary systems required for its operation (Project Mercury).

The initial appropriation of $125,000,000 was very soon supplemented by special and additional funds and has meanwhile reached the impressive total of over $300,000,000. When NACA was incorporated in the new Federal administration on September 30th, 1958, the latter took over more than eight thousand scientists, engineers and technicians and all the NACA research establishments. The most important laboratories are now known as *Langley Research Center* (formerly Langley Aeronautical Laboratory, Langley Field, Virginia), *Ames Research Center* (formerly Ames Aeronautical Laboratory, Moffett Field, California), *Lewis Research Center* (formerly Lewis Flight Propulsion Laboratory, Cleveland, Ohio). The High Speed Flight Station, at Edwards AFB, California, the Pilotless Aircraft Research Station, at Wallops Island, Virginia, and the Plum Brook Research Reactor Facility, at Sandusky,

National Aeronautics and Space Administration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LIAISON OFFICES
WALLOPS STATION
*/ Safety Officer

Ohio, have retained their former names. Existing policies, regulations and similar matters governing NACA activities continue in effect until changed or abolished.

A few weeks after NASA came into being, Dr. Thomas Keith Glennan, President of Case Institute of Technology, Cleveland, Ohio, was appointed Administrator; Deputy Administrator is Dr. Hugh L. Dryden, former Director of the National Advisory Committee for Aeronautics. As Chairman of the Institute of Defense Analysis and former member of the Atomic Energy Commission, Glennan has a deep insight into the problems of defence research and ... excellent contacts with Government agencies and the armed services.

Nevertheless, the first difficulties and frictions between NASA on the one hand and the Advanced Research Projects Agency and the three services on the other were not long in coming. The question of the giant rocket engine for 1,000,000 lb. thrust, which has been demanded by many "customers" and is the joint responsibility of NASA and ARPA, led to the first disagreements.

An open conflict broke out when NASA tried to take over the Army Ballistic Missile Agency of Huntsville, Alabama, arguing that the weapons the latter was developing were part of the U.S. space programme. Over 2,000 Army missile specialists, including more than a hundred German experts who went to the United States after the war, were involved in a jurisdictional dispute between the U.S. Army and the new space agency. NASA Administrator Glennan asked Army Secretary Wilber M. Brucker to turn over to NASA a large number of missile scientists and engineers employed at the Army's Redstone Arsenal, Huntsville. In addition Dr. Glennan asked the Army to surrender the entire facilities and personnel of its Jet Propulsion Laboratory at Los Angeles. The Army protested to President Eisenhower. The disputed issue was not so much who should control America's space programme, as what that space programme includes.

It was not until December 3rd, 1958 that the dispute was settled by a ruling by President Eisenhower, who decided that the Army should retain control over its ballistic missile agency at Huntsville. On the other hand, the Army was ordered to hand over the Jet Propulsion Laboratory which at present employs some 2,300 scientists. Although the President's decision appears at first glance to have been a victory for the Army, the Army's role in the overall space programme may now diminish to a point where there will not be enough work to occupy the scientists employed at Redstone and they will presumably begin drifting into NASA.

Although the National Aeronautics and Space Administration is still complaining of an acute shortage of specialist personnel, political and military observers in Washington believe that it may soon become as influential as the Pentagon or the Atomic Energy Commission. The 2,100 specialists from the Army Ballistic Missile Agency would have done much to improve the staff position; however, the shortage of personnel did not prevent NASA from announcing an impressive rocket programme at the beginning of 1959.

Under this programme NASA plans to acquire 18 to 20 large rockets from ABMA and another ten from the Air Force Ballistic Missile Division, for various civil space projects. Firm arrangements have been made for the procurement of twelve *Jupiter C*, *Thor/Vanguard* and *Thor* carrier vehicles, with a Lockheed second stage of undisclosed designation. These will be employed to launch satellites weighing between 100 and 150 lb., for research into cosmic radiation, meteorological and geodetic measurements. The actual satellites will be furnished by the USAF's Cambridge Research Center, the Army Signal Corps laboratories at Fort Monmouth, New Jersey, and various universities. NASA's *Vanguard* division will also build several payloads. The majority of these vehicles will be launched from the Pacific Missile Range (Vandenberg AFB). The first test firings this year will be two satellite launchings in the *Discoverer* programme, a joint NASA and ARPA project employing the USAF's Douglas *Thor* with the Lockheed second stage.

The U.S. Navy will not furnish any vehicles other than the *Vanguards* which have already been handed over to NASA. However, much discussion has arisen on the possible use of the *Polaris* solid-propellant IRBM as a satellite carrier vehicle, since it has a high specific impulse and mass ratio. The more advanced *Polaris B* model, with a first and second stage by Aerojet-General, will be ready by August 1959.

NASA apparently has no firm plans for a resumption of lunar firings with the USAF's *Thor/Vanguard* vehicle. However, there are several active plans for advanced space probes using super rockets composed of clustered groups of *Atlas* and *Titans*, but these vehicles are unlikely to be available before early 1960. Nevertheless, there is a possibility that this year may perhaps see an attempt to launch at least one Mars probe, using an *Atlas* first stage with a Lockheed-Bell second stage and *Vanguard* third stage, with a 35-lb. payload.

In addition to these developments, NASA's Lewis Research Center at Cleveland, Ohio, is carrying out a research programme on a high energy scheme for liquid hydrogen and oxygen reactions units. This reaction will be tried out in 10,000-lb. thrust chambers and may actually be flight tested in a small NASA rocket. Parallel to the NASA programme, Pratt & Whitney's Palm Beach plant in Florida is working on the development of a hydrogen-oxygen engine for manned space flight; this is an ARPA project designated *Centaur*.

*

A truly ambitious programme, which cannot be described in detail in these pages—a programme which nobody would have taken seriously twelve months ago, but which will reach a first climax in a very few years with the first launching of the manned Mercury satellite.

Wanted : Spaceman

On December 17th, 1958, Dr. Thomas Keith Glennan, Administrator of the National Aeronautics and Space Administration, disclosed that the United States was working on "Project Mercury" to launch a manned satellite weighing more than a ton. Although the long-term project could not be realized for "several years" at the earliest, selection of a round dozen candidates to make the Western World's first manned space flights has already begun.

At the beginning of November, the U.S. aviation industry was invited by NASA and ARPA to participate in a design contest for the manned satellite capsule, and was provided with specifications for the cabin, which will be in the shape of a truncated cone and carry a wealth of instruments. The following are some of the companies who took part in the competition: Avco Manufacturing Corporation, Convair Division of General Dynamics Corporation, Douglas Aircraft Company, Grumman Aircraft Engineering Corporation, Lockheed Aircraft Corporation, McDonnell Aircraft Corporation, North American Aviation Inc., Northrop Corporation, Republic Aviation Corporation, Winzen Research Inc.

In mid-January 1959 it was announced that McDonnell Aircraft Corporation of St. Louis had won the NASA contract for the satellite capsule, and is now working at high pressure towards the construction of the first manned capsule which will carry a man several times round the earth and return him safely to the ground. The United States is apparently in a hurry for the project to be completed ... Soviet reports state that the first human will be launched into space as early as 1960.

The details published so far on Project Mercury reveal at any rate that NASA is undertaking a huge programme which, after innumerable preparatory tests, will culminate in an ambitious undertaking: the launching of a manned satellite capsule onto a nearly circular orbit at an altitude of 100 to 150 miles. The satellite will have a life of about 24 hours before reverse thrust rockets and special drag parachutes are employed to bring the occupant safely back to earth. The contract apparently caters for the building of several of these capsules, each of which, together with its related sub-systems, will cost approximately $15 million. NASA has not yet given any indication of when the first manned orbital attempt will be made, but it is estimated that at least two years will be required for the development and testing of the hardware.

The capsule itself will be conical in shape, of a high drag, zero lift configuration, with an overall diameter of 6.25 ft. During launching, the passenger will be required to take up a crouching position facing skywards. The vehicle will be equipped with a two-way voice radio, a data link receiver for ground commands, telemetry, a tracking beacon, an optical display permitting the pilot to see the earth's horizon, and control instruments allowing him to control the attitude of the vehicle with reaction jets. An automatic attitude sensor will also be included, and the necessary corrective manœuvres could also be directed from the ground control stations. Although the passenger will be provided with sufficient quantities of food, water and oxygen for a period of 24 hours, it is not anticipated that the first test flight will make more than a few circuits of the earth.

The capsule will be placed in orbit by an *Atlas D* ICBM, a version which will not become available for tests until the autumn of this year. The capsule will include an escape rocket to lift it clear of the booster in the event of a malfunction of the *Atlas* rocket during launching. In this case the special rocket (later jettisoned) attached to the capsule would throw it half a mile skyward and to one side, permitting the passenger to parachute down away from the blast-off area. Together with the escape rocket, the vehicle will weigh approximately 2,400 lb.

At the beginning of the re-entry phase the attitude of the capsule will be reversed by the attitude controls so that the passenger will be subjected to the deceleration force in a rearward facing position. Signals from the ground station would then fire four retro-rockets fitted underneath the capsule to permit re-entry in less than one half of an orbital revolution. According to the American press, the spaceman might be subjected to 10 g of deceleration during re-entry. When the capsule is decelerated to approximately Mach 1, a metal drogue parachute will be opened to insure stability. As the velocity continues to fall, the landing parachute will be opened. Before the landing parachute opens, it is planned to eject the heavy (and hot) metal protection plates behind the pilot's back (see drawing). Shortly before landing a rubber pad in the rim of the capsule will be inflated to assure either a soft ground landing or buoyancy in water.

In order to facilitate recovery of the vehicle after landing, the following aids are included: a radio beacon (on board the capsule), two-way radio, a flashing light visible over a long range, dye markers to colour the surrounding water, small depth bombs, plus a quantity of radar chaff which will be ejected during the later stages of the descent.

*

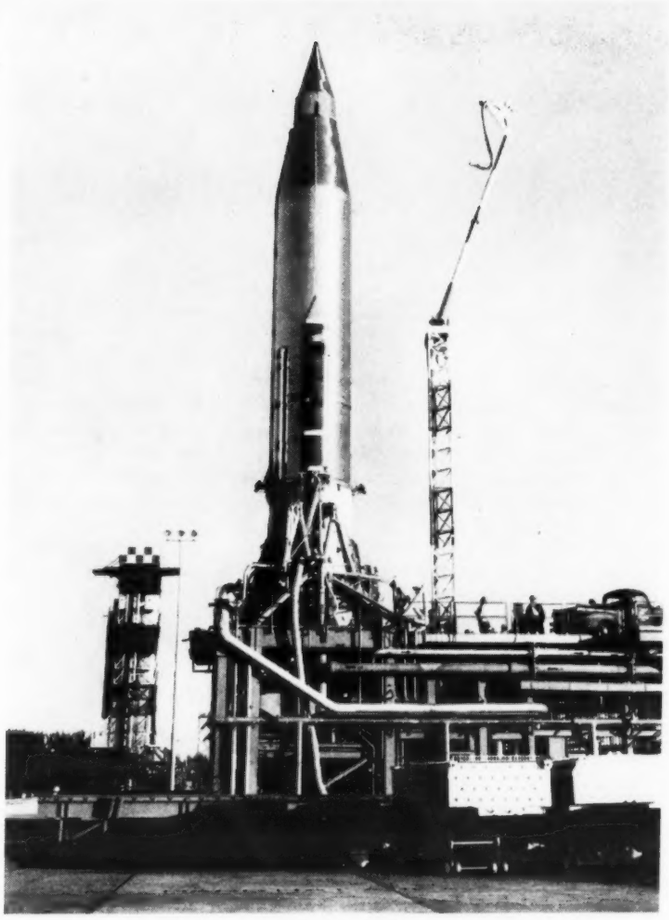
Preparatory tests under the Mercury programme have already begun. Some time ago NASA acquired several U.S. Army *Redstone* rockets for ballistic tests of capsule mockups. Several mockups and experimental prototypes of the Mercury manned space capsule have already been built by NASA's Langley Research Center. Drop tests of these capsules from high-flying aircraft have established that the shape and volume of the truncated-cone capsule is sound, but several problems have arisen in the soundness of the heat-sink concept, and current thinking is towards the employment of a beryllium heat absorbing shield instead of the ablation ceramic or plastic nose cone envisaged earlier.

Several space vehicle launchings with monkeys and other animal passengers are scheduled for the coming summer months, using *Redstone* rockets, but later larger vehicles will be projected into space by clusters of solid-propellant U.S. Army *Sergeant* rockets (project designation Little Joe), and finally *Thor* and *Atlas* rockets. The first manned experimental capsule will probably be launched by a *Redstone* rocket, but will not be put into orbit. It will be at least a year to eighteen months before an orbital shot with animal passengers is attempted, and it is unlikely that a manned orbital attempt will be made before the beginning of 1961.

*

However, the NASA Aeromedical Committee, headed by Dr. W. Randolph Lovelace, is screening no less than 110 potential candidates for the manned satellite. But of these, only 12 will be chosen for the Project Mercury team. Each candidate must be a university graduate, have graduated from one of the military test pilot training schools, and have a minimum of 1,500 hours of flight time in his log book. He must be younger than 40, and not taller than 5 ft. 11 in. The dozen volunteers will be totally involved in a programme of rigorous training, including simulated tests to prepare them for their unusual task. They will be assigned to the NASA Space Task Group, located at Langley Research Center, and be given additional training at the Johnsville Naval Air Development Center, where they will undergo training in a centrifuge that very nearly simulates conditions in a capsule during take-off and re-entry. The early testing period will involve balloon flights in pressurized Mercury capsules.

Very many tests with unmanned capsules, and first manned flights to great altitudes are planned before NASA will venture to take the final step. "We are determined," said NASA Administrator Keith Glennan, "that the risks to the pilot will be no greater than those experienced during the first flights of a new, high performance airplane."



An *Atlas* satellite carrier rocket ready for launching on its pad at Cape Canaveral.

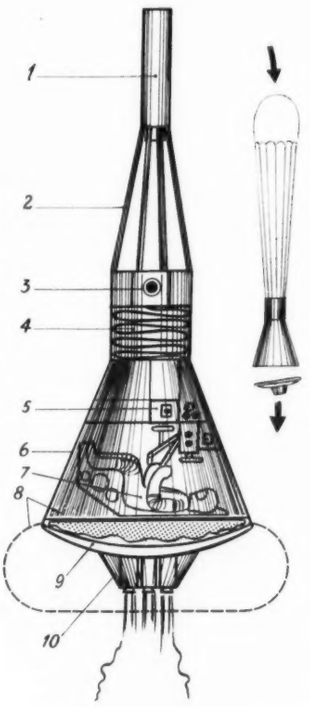


Diagram of the first U.S. manned satellite, as under development at McDonnell under Project Mercury. 1. jettisonable escape rocket to throw capsule clear if the carrier rocket misfires; 2. support for escape rocket; 3. periscope for optical checking of the satellite position in space; 4. folded drag parachute; 5. instruments; 6. conical satellite housing; 7. spaceman; 8. folded rubber pad (the dotted line shows the inflated pad); 9. heat shield for re-entry into the atmosphere; 10. retro-rockets.

Brief Chronicle of Common Defence

Bilateral and Multilateral Agreements under NATO

The provisional buildings forming the Paris headquarters of NATO are quietly falling to pieces between the solid wings of the new Trocadero, and the whole North Atlantic Treaty Organization is wavering under the combined blows of the Russians and of Western nationalism. Yet it is turning out floods of eloquence and tons of documents in an effort to get the wheels of industry turning in Europe. And, after years of beating about the bush, a certain degree of integration of arms development and production is at last underway.

The *Fiat G.91* affair now appears to have been settled. This aircraft is required to support the ground troops in the kind of widely dispersed operations which would be necessary under the atomic threat. In the age of surface-to-air defence missiles, this would be the only category of aircraft which could penetrate enemy territory at very low altitudes for reconnaissance and strike purposes. Italy, Germany, Greece and Turkey, in short the countries in direct contact with the Iron Curtain, all plan to use this aircraft on SHAPE's recommendation.

The Fiat aircraft for close-range attack will be accompanied by *Hawk surface-to-air missiles* for short-range defence. France at present appears to be reluctant to release the 150,000 million " light " francs which has been fixed as her contribution to the project, but since Thomston-Houston is to be main contractor for the weapon in Europe, there seems little doubt that these funds will eventually be forthcoming. Between them France and Germany will contribute to the " kitty " instalments totalling some $600 million, and Western Europe will be protected against attack by low-flying aircraft. The potential aggressor—if he exists—will have no choice but to use some of his stocks of T3 or T4 missiles.

NATO's most recent project is that for the *Naval reconnaissance aircraft*. France took first place in the prototype contest with the Breguet 1150, but so far it has not been possible to provide the funds needed for building this aircraft, testing it, producing it in quantity and operating it. It looks as if the European navies, all of them kept somewhat short of cash, will have to turn to Uncle Sam for help.

The *transport aircraft for a payload of 8 tons* and the *heavy helicopter* are at the moment bilateral rather than multilateral projects. Germany and France are sharing both the work and the financing, but hoping that the United States will contribute a few million dollars under the Mutual Weapons Development Team concept, and that other countries will show an interest in these designs. But at the moment other countries are more interested in the Lockheed *Hercules B* or the Armstrong Whitworth *Argosy*.

Drawing of the projected Breguet 1150 Naval reconnaissance aircraft, with two Rolls-Royce *Tyne* propeller turbines; take-off weight, approximately 38 tons.

Another bilateral arrangement is the F-104 agreement between the United States and West Germany. The aircraft in question here retains the powerplant, fuselage and basic wing design of the F-104, but will carry a complex, multipurpose electronic system developed by the Autonetics Division of North American Aviation. The new F-104, which has been given the works designation Lockheed 683-5, will meet the requirements of German strategy and, more generally, of other Western European countries. The best American equipment manufacturers—Bendix, Collins, Garrett, etc.—have contributed to the success of this aircraft. Fundamentally, the Bonn-Washington agreement means that American powerplant design and electronics will be firmly implanted in Western Europe.

But NATO's efforts in the defence field have not been limited to the *Hawk* missile. In addition to trying to introduce intermediate range ballistic missiles into Europe, it will shortly be circulating specifications for a ballistic missile especially suited for the European theatre. This is designed to replace today's F-100 fighter-bomber and tomorrow's F-105.

When they take up their new quarters in the Palais de la Porte-Dauphine, the inter-allied organizations will take with them a few old projects and a large number of new ones. History will say of them that they accomplished less than had been expected, but more than is generally admitted.

The U.S. Army's Raytheon *Hawk* surface-to-air guided missile is designed for close-range air defence. Compagnie Française Thomson-Houston of Paris will play a leading role in the European *Hawk* programme.

Finally, at least one squadron of unmanned Boeing IM-99 *Bomarc* fighters (for ranges up to 250 miles) will go to the U.S. Armed Forces in Europe. Picture shows a USAF Air Defence Command *Bomarc A* at Eglin AFB, Florida.

Giant Airfield Refueller for the Jet Age

A Strüver airport refuelling truck such as Esso Standard Switzerland uses at Zurich and Geneva Airports. Capacity 7,700 Imp.gals. A larger model (capacity 10,000 Imp.gals) is also built by the Hamburg company.

Every service station attendant knows the name of Strüver. Fuel companies such as Esso, BP and Shell use fuel trucks designed by this Hamburg firm at several dozen airports. In order to meet the requirements of the jet age, Strüver has built a giant airport refueller with a capacity of 7,700 Imp.gals. Just recently Esso Standard Switzerland placed Strüver trucks in service on Switzerland's two intercontinental airports—Cointrin, Geneva and Kloten, Zurich. Their capacity of 7,700 Imp.gals is sufficient for the rapid and economical refuelling of the largest long-range commercial airliners, including the new jet aircraft now coming into service.

Fully loaded, the fuel trucks weigh 45 tons apiece. The towing vehicle and the corrosion-resistant, cantilever light metal tank run on a total of fourteen air tyres; overall length is 50 ft. 2 in. It is drawn by a Swiss-built Berna Type U5 traction vehicle which suits both the technical requirements of airfield refuelling and the external shape of the Strüver fuel truck.

The complete fittings and equipment, which have a delivery rate of 530 Imp.gals/min, are housed in a cabin behind the driver's seat (cf. diagram). A high-pressure centrifugal pump, powered by the vehicle's engine, feeds the fuel from the tank to the aircraft. Here a special device separates out any water which may have been deposited in the fuel by condensation. To guarantee the absolute purity of the fuel, it is passed through a five-micron-gauge filter, and the amount of fuel delivered can be determined volumetrically by means of a meter.

The fuel tanks of the aircraft in both wings are filled at the same time through two 98.4-ft. hosepipes of 2 in. internal diameter. By means of a simple reversal switch the fuel can be returned to the truck's tanks from the aircraft, and again the amount is accurately measured by a meter.

The heart of the refueller's equipment, permitting independent control of the individual deliver, y points is a Strüver-developed patent control valve installation, which permits either over or under-wing refuelling, and even with varying flow strength guarantees a constant pressure at the hose end. This constant pressure is necessary to ensure the fastest possible refuelling speed, thus reducing the time required for the operation to the absolute minimum.

Apart from its giant airfield refuellers, the Strüver programme also includes the manufacture of airport hydrant vehicles for flow metering and filtering of aircraft fuels during direct refuelling from ground sources. Also constructed are water-methanol supply vehicles (with V2A steel tanks and hand pump), starter units in various sizes (with air-cooled Deutz Diesel engine), and helicopter refuellers to filter, meter and deliver fuel from underground hydrants.

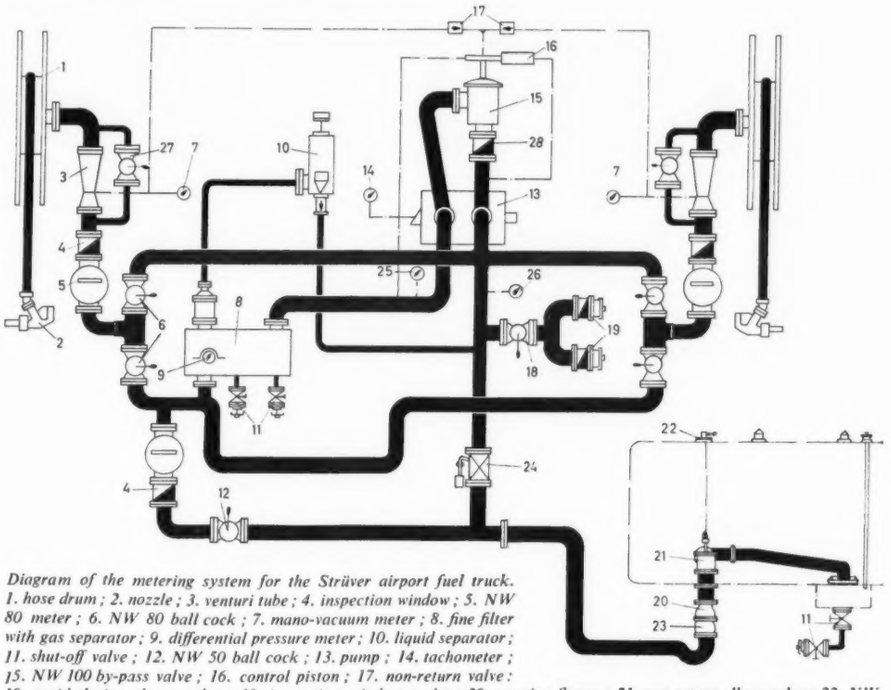


Diagram of the metering system for the Strüver airport fuel truck. 1. hose drum; 2. nozzle; 3. venturi tube; 4. inspection window; 5. NW 80 meter; 6. NW 80 ball cock; 7. mano-vacuum meter; 8. fine filter with gas separator; 9. differential pressure meter; 10. liquid separator; 11. shut-off valve; 12. NW 50 ball cock; 13. pump; 14. tachometer; 15. NW 100 by-pass valve; 16. control piston; 17. non-return valve; 18. rapid-closing sleeve valve; 19. inspection window outlet; 20. rotating flange; 21. non-return elbow valve; 22. NW 100 hoisting device; 23. elastic coupling; 24. valve; 25. manometer; 26. vacuum meter; 27. NW 32 ball cock; 28. inspection window.

Bendix in Europe

The name of Bendix, of course, needs no introduction in Europe. The two three-day engineering conferences which Bendix Aviation Corporation organized in Frankfurt and Paris in the early part of February, were therefore designed not to present a newcomer but to strengthen the company's thirty-year contacts with the European market and to provide first-hand technical information on its latest developments. As Arthur E. Raabe, Vice-President of Bendix Aviation, told the press in his speech of welcome in Paris, his company believes that the opening of the Common Market and the emergence of new trade patterns in Western Europe call for a new approach to relations with the Old Continent. Incidentally, the list of European firms producing Bendix equipment under licence contains 42 names (in seven countries), and a total of 32 firms (in 19 countries) are linked in the sale of Bendix products.

Both conferences also featured an exhibition of a representative cross-section of the products from Bendix' 26 manufacturing divisions, while more than 30 leading Bendix engineers explained the latest developments in lectures or demonstrations. In the field of air navigation and communications, recent products of particular interest include new versions of the PB-20 Flight Control System (e.g., for the Boeing 707 jet airliner, the Douglas A4D-2N attack aircraft and the Convair B-58 *Hustler* supersonic bomber); two- or three-gyro stable platforms; a Position and Homing Indicator (PHI) for fighter aircraft, built by Computing Devices of Canada and marketed by Bendix; the ASN-19 dead reckoning computer; the 21 Series of miniaturized VHF communications and navigation equipment; airborne radar equipment for navigation (DRA-12 Doppler radar) and weather observations (RDR-1D); and finally a projected weather reconnaissance system, the AN/AMQ-15, for installation in the USAF's jet transports.

Under the AN/AMQ-15 programme, for which the USAF plans to provide funds totalling more than $30,000,000 over the next three years, first the Boeing 707 prototype and later a number of Boeing KC-135 tanker-transports will be converted into flying weather observation stations. Armed with extensive equipment weighing several tons, and with rocket and parachute sondes, these aircraft will operate at altitudes of up to 55,000 ft., over ranges of up to 4,800 nautical miles. They will measure, record and evaluate more than a dozen meteorological parameters, from ground level up to 150,000 ft.

The several hundred specialists from all over Europe who attended the conferences also heard with interest other reports on Bendix investigations in the fields of undercarriage and brake design, powerplant controls, high-temperature hydraulics, etc.

The highlight of the conference, however, was probably the lecture by L. B. Young, who is responsible for long-term planning at the Bendix Systems Division, Ann Arbor, Michigan, and who concluded

his remarks with a brief reference to a number of new missile projects. For some years Bendix has been the main contractor for the U.S. Navy's *Talos* surface-to-air missile, which is now in large-scale production and which can be employed with either nuclear or conventional warhead. In addition, the company is a sub-contractor in the development and production of the following missiles: *Atlas* and *Titan* ICBMs, *Thor* and *Polaris* IRBMs, *Pershing* short-range rocket, *Nike Ajax*, *Nike Hercules*, *Tartar* and *Terrier* surface-to-air missiles and the WS 117L observation satellite.

New Bendix developments include an air-to-air missile (*Project Eagle*) and two target drones (*Penny* and *Hilo*) which could also be used for other roles later. The Eagle air-to-air missile, developed for the U.S. Navy, is a long-range supersonic weapon of high accuracy, and has been specially designed for the task of protecting naval units against surprise attacks from the air. For this mission, *Eagle* can be operated over a wide altitude range and launched from *any* carrier-based subsonic or supersonic aircraft at long ranges from the attacker. Its guidance system is practically immune from radar jamming and is integrated with the fire control system of the whole fleet unit.

The *Penny* and *Hilo* drones have been developed by Bendix as complete weapons systems with all the relevant launching aids and test equipment, and are fitted almost exclusively with Bendix equipment elements. The *Penny* is rocket-powered, with very slender body, small delta wing, horizontal stabilizers on the nose and vertical stabilizers at the rear. Its equipment includes a Bendix Radar Lens (a plastic sphere for increased reflection of radar signals in the X-band), a radar repeater beacon for increased reflection in the L and S-band, an infrared radiation amplifier and an electronic hit and miss-distance indicator. The *Penny* is launched in the air from a carrier aircraft and is described as an expendable equipment.

The *Hilo* ramjet-powered drone, on the other hand, is launched from the ground with the aid of a rocket motor on the rear of the fuselage and can be recovered after flight. When the take-off booster has been jettisoned, a Marquardt ramjet beneath the fuselage supplies power for the roughly 23-ft. vehicle. For special missions the *Hilo's* wing and tail surfaces can be enlarged by adding extra leading edges to the delta wings and the rudder unit. Its equipment is similar to that in the *Penny*. Young said that Bendix also proposes the use of missiles of this category as decoys or carriers of radar jamming equipment; consideration is also being given to a version for tactical observation missions.

During the 1958 business year the various Bendix divisions recorded total sales in the missile field valued at $78,800,000. At the end of last year the total order backlog stood at $107,400,000. As Vice-President Raabe said with understandable satisfaction at the Paris conference: " Every rocket that has been fired by the U.S. Government at Cape Canaveral, Florida, has had Bendix-produced equipment aboard."

Book Reviews

VIIIth International Astronautical Congress, Barcelona 1957. Editorial Board: P. J. Bergeron, W. von Braun, K. A. Ehricke, F. Hecht, J. Marial, E. Sänger, K. Schütte, L. I. Sedov, L. R. Shepherd, S. F. Singer; Editor-in-Chief, F. Hecht. Springer-Verlag, Vienna, 1958 (German, English, French, Italian, Russian: 607 pages: 233 illustrations; price, cloth-bound, 128 Swiss francs: DM 125.00; 750 Austrian schillings: $29.75; £10 12s 6d).

This volume contains all the papers read at the 8th International Astronautical Congress in Barcelona and approved by the IAF Committee. The result is a highly valuable scientific and historical document. A reading of the IAF papers recalls the series of stirring events ushered in by the first Russian satellite (launched on October 4th, 1957). The Congress in fact foreshadowed the whole development leading to heavy satellites, lunar probes and space weapons of various configurations, and to basic rethinking by statesmen and military experts. Re.

" C.F.S. " — Birthplace of Air Power. By John W. R. Taylor. Published by Putnam & Co. Ltd., London, 1958 (English: 222 pages; 15 pictures. 21 shillings).

This book traces the history of Britain's Central Flying School—more familiarly known by the initials C.F.S. throughout the world's military aviation circles—from the date of its foundation in 1912 up to the missile age. The fact that from all over the world the nations have sent, and are still sending, pilots for training, pays tribute to the role which the school has played in military aviation. This history is interlaced with many stories of the high spirits indulged in by men whose names are today famous in the history of the Royal Air Force. The pictures range from the early stick-and-string biplanes up to modern jet aircraft. Ru.

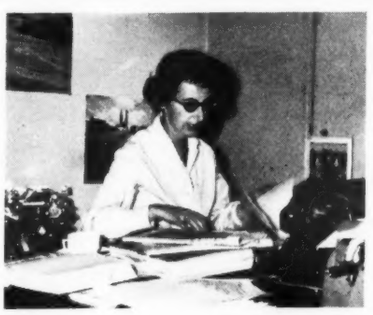
Jane's All the World's Aircraft 1958/59. Compiled and edited by Leonard Bridgman, with the assistance of John W. R. Taylor. Sampson Low, Marston & Co., Ltd., London, 1959 (English: 532 pages; £5 5s 0d).

Like its predecessors, the 49th edition of this standard reference book has again been considerably enlarged. In particular the chapter devoted to missiles, classified according to countries and manufacturers, gives the available data on practically all weapons of any importance. The general arrangement of the book, which has been proven through many years, is unchanged: military aviation, civil aviation (with details of the structure and activities of ICAO, IATA, FAI, a list of world records and information on the world's leading airlines); aircraft; missiles; powerplants; airships. Another very useful feature is the table of first flights which took place in the period from September 1st, 1957, to August 31st, 1958. The book's 532 pages show some 1,000 photographs, a good fifty percent of which are new. Ba.

Das Buch der deutschen Fluggeschichte. New Edition, in two volumes; Vol. I from earliest times to 1912; Vol. II from 1913 to 1932. By Peter Supf. Issued by the Verein zur Förderung des deutschen Luftsports, on the initiative of the German Aero Club. Drei Brunnen Verlag, Stuttgart, 1956 and 1958 (German; Vol. I, 600 pages, Vol. II, 736 pages; price per volume DM 39.00).

For a quarter of a century the first edition of this two-volume work was a standard history for Germans —and others—interested in aviation. Like the French aviation history by Dolfus and Bouché or the Swiss volume by Tilgenkamp, it was a must in every aviation library. The new edition, sponsored by the German Association for the Promotion of Sports Flying, is particularly welcome since Peter Supf is one of those unfortunately somewhat rare writers who can rouse enthusiasm among their readers because they are themselves enthusiastic about their subject.

It is regrettable that the new edition has not been continued beyond 1932/33, although this might admittedly have been difficult. So many of the names which appeared in every German publication during the Hitler period have now fallen into disrepute. Such names have been removed from the present edition, and others, omitted from the first edition (such as Professor Theodore von Karman, to mention but one example) have been added. Not that the author can be accused of political bias in either case; he is interested solely in aviation and in the men connected with aviation, regardless of their other allegiances. Hence the new aviation history deserves the widest possible circulation. He.



Juta Turkova

With deep sorrow we have to announce that our colleague Miss Juta Turkova died on February 11th, 1959 after a short illness, a few days before her 35th birthday. After graduating from Cambridge and working as a journalist in England and Switzerland, she joined " Interavia " in October 1955 as editor of the English Air Letter, a post which she filled with complete devotion until just before her death.

In Miss Turkova we have lost a valued friend and colleague. We shall not forget her loyalty and her courage in the face of the many adversities life brought to her.

INTERAVIA

Start in die dritte Dimension. By Alfred Fritz, with 52 drawings by Theo Lässig. Herold-Verlag, Stuttgart, 1958 (German; 224 pages; price DM 14.80).

" . . . At the end of the Modern Age the inhabitants of this earth, who in their heart of hearts are still thinking on a geocentric level, are unwilling to realize that in future it will be not only the telescope that will open up terrestrial space, but that they themselves will be called upon to reach up to the stars. What can there be against this way to the stars if man can be persuaded to reflect on himself and his place in the world in which he lives."

These words, with which the present book closes, reveal the programme of its author who, as head of the German Rocket and Space Museum, is fully qualified to carry the reader into the highest regions. The question of whether the Wright Brothers and Clement Ader could not claim to have taken the first step into the third dimension, which the author reserves for the rocket, will not be discussed here. At any rate, his clearly written history of space travel—from Goddard to *Sputnik III*—is a valuable addition to aviation literature for the non-technical reader. He.

Jahrbuch 1957 der Wissenschaftlichen Gesellschaft für Luftfahrt (WGL). Edited by Professor H. Blenk. Friedr. Vieweg & Sohn, Brunswick, 1958 (German; with four contributions in the original English: 504 + VII pages; 623 illustrations; price DM 58.00).

The sixth of the yearbooks so far published by the new WGL is again devoted primarily to the papers read at a scientific conference, namely the joint congress sponsored by the WGL and DVL in Essen from April 9th to 12th, 1957. An interesting point is that leading DVL personalities have contributed 17 papers, or a good third of the total of this impressive tome, and provided interesting glimpses of recent research work. The remaining 32 contributions, most of them guest papers or even dissertations, were sponsored by the WGL. Overall impression: like its predecessors, an illustrative cross section of the many problems today being tackled by aeronautical research. Ri.

Einführung in die Theorie der Strömungsmaschinen. By Professor Albert Betz. G. Braun, Karlsruhe, 1959 (German; 272 pages; 168 illustrations; price, cloth-bound, DM 36.00).

Professor Albert Betz, Director Emeritus of the Aerodynamische Versuchsanstalt, Göttingen and of the Max-Planck-Institut für Strömungsforschung, was a close collaborator of Ludwig Prandtl for more than four decades and is well known as co-founder of modern airfoil theory and author of many publications in the varied fields of fluid flow. The present " Introduction to the Theory of Flow Machines ", which is fundamentally a carefully planned and comprehensive textbook, deduces from the basic phenomena of fluid flow the most important laws of flow in conduits and housings. The sections on cascades of blades is particularly detailed, though the main weight of the book is to be found in a systematic discussion of all forms of flow machine —from pumps, fans and compressors, via hydraulic turbines, steam and gas turbines to propellers and jet engines.

The matter is clearly presented and well illustrated, and there is an extensive bibliography. The book will undoubtedly be of valuable service to countless scientists, engineers and students with a command of the German language.

Ri.

British Naval Aircraft 1912-1958. Compiled by Owen Thetford and published by Putnam & Co. Ltd., London, 1958 (English; 426 pages; 50 shillings).

No better summing-up of this reference book can be found than the publishers' own words on the dust cover: " This is the first complete reference book to all the aircraft ever flown in regular service by the Naval Wing of the Royal Flying Corps, the Royal Naval Service and the Fleet Air Arm. Produced as a companion volume to Mr. Thetford's ' Aircraft of the Royal Air Force 1918-1958 ', it contains the maximum possible technical data, covering performance, dimensions, armament and weights. In addition to a general narrative tracing the development history of these many types of aeroplanes, details are included of the dates of maiden flights, numbers of each type built, particulars of sub-contractors, lists of Squadrons or Flights equipped with the type, aircraft-carriers with which they have operated and in most cases, details of serial number allocations. There are over 360 photographs and over 100 three-view drawings."

Ru.

The Command of the Air. By General Giulio Douhet. Published by Rivista Aeronautica, Rome, 1958 (English; 202 pages).

In the period between the two World Wars the name of Douhet was quoted in the more informed early Anglo-American writings on air strategy, but wider military circles apparently gave scant attention to the now historically famous " Douhet Theory ". First published in 1921, Douhet's prophetic visions of the future significance and employment of Air Power became a reality in World War II in the hands of the British and United States Air Forces. This new official English-language edition of his writings includes, in Book I, Douhet's 1921 theories on the new form of warfare, the air forces required, the general principles of air warfare and consideration of the organization of an air force; Book II, written in 1926, amplifies and extends the original papers, while the third section —summing up—is a résumé of the various discussions to which his theories had given rise, and was compiled by General Douhet in 1929.

Ru.

Hier is Schiphol. By Hugo Hooftman. In the " Zwarte Beertjes " collection, published by A. W. Bruna & Zoon, Utrecht, 1958 (Dutch; 156 pages; photos).

In this little paper-back pocket book one of Holland's best-known aviation writers tells the story of Amsterdam's international airport—and in part of KLM—for the man in the street. Early beginnings in 1919, pre-war growth, destruction during the war, rebirth, present activities and plans for future expansion. The text is supplemented by photographs and tables listing growth statistics, services operated, types of aircraft in use, etc.

St.

The Prediction of Ballistic Missile Trajectories from Radar Observations. By Irwin I. Shapiro. McGraw-Hill Book Company, Inc., New York, Toronto, London, 1957 and 1958 (English; 208 pages; price 54s 6d).

This book by I. I. Shapiro, of the Lincoln Laboratory, Massachusetts Institute of Technology, deals in great detail with the topical problem of predicting ballistic missile trajectories and is written for the specialist, who must have considerable mathematical and physics knowledge before tackling it.

Na.

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The article entitled " Canada's Aviation' 1909-1959 ", in the February issue (page 173), described John A. D. McCurdy as not only " the first of the surviving old-time pilots to have flown in the world ", but as " now the oldest in years, 73." Without in any way wishing to belittle McCurdy's achievements, the following letter sets this claim in a new light.

Sir,

I have just read in Interavia No. 2 for this year, a magazine to which we are regular subscribers, the story of John A. D. McCurdy, the friend of my brother Henri who died last year.

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Yours sincerely,

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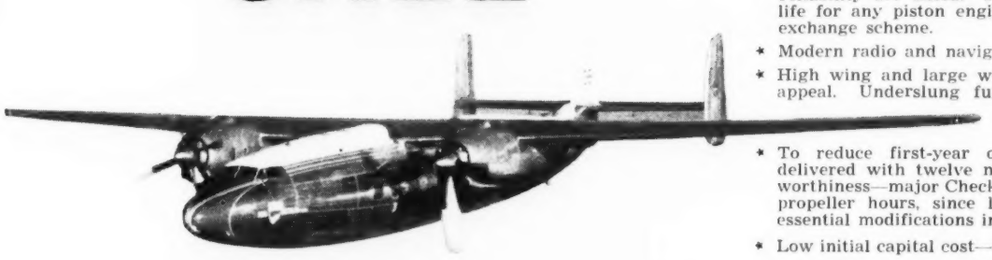

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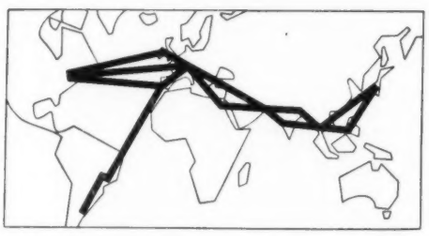

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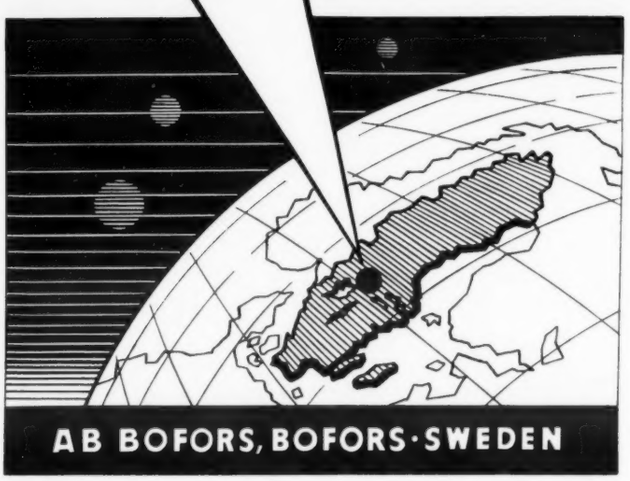

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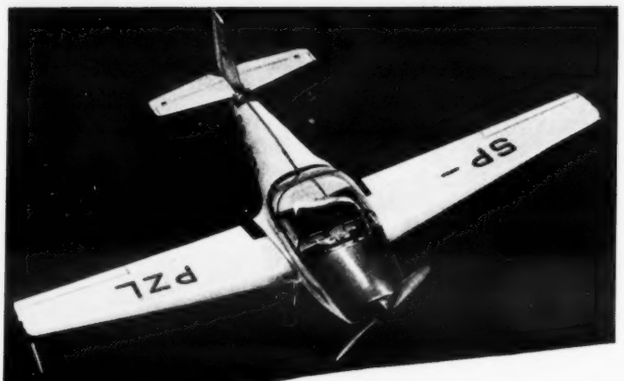

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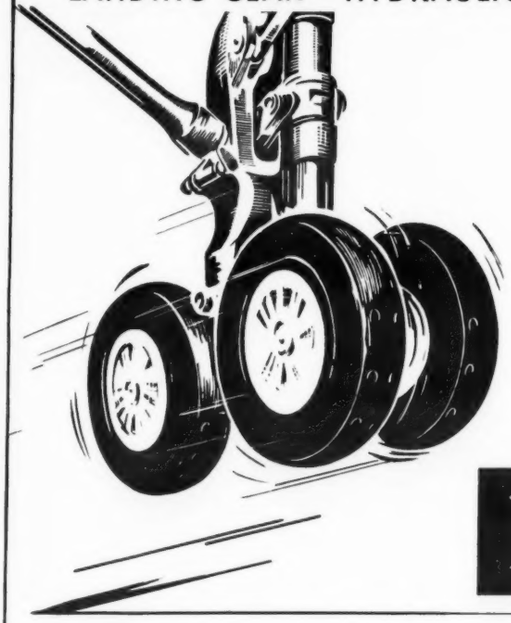

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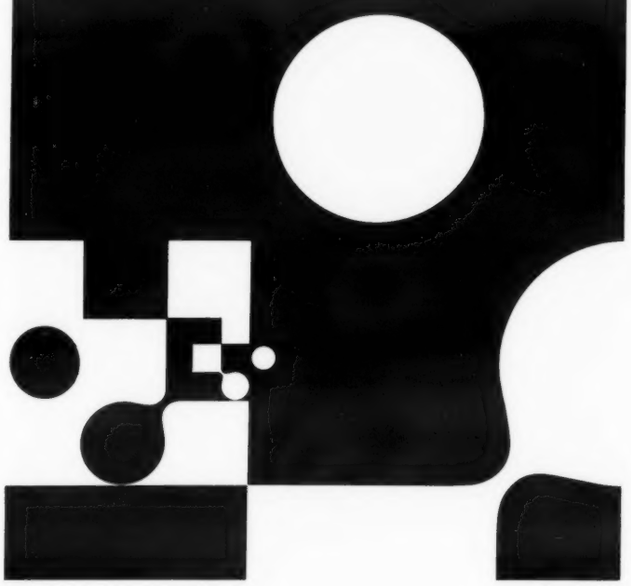

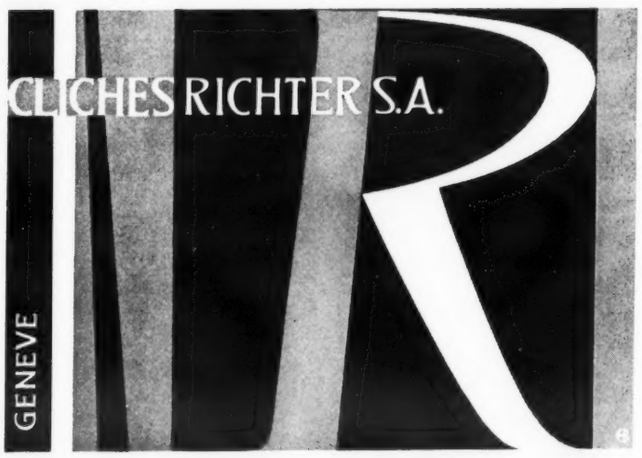

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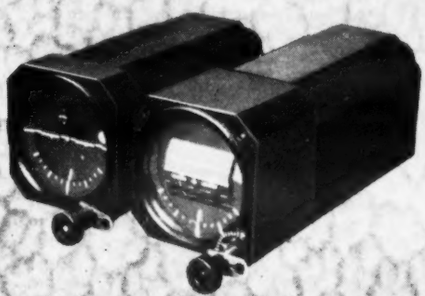

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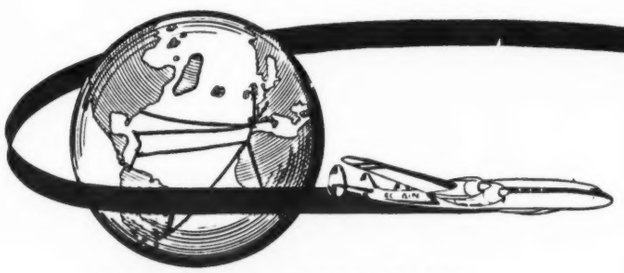

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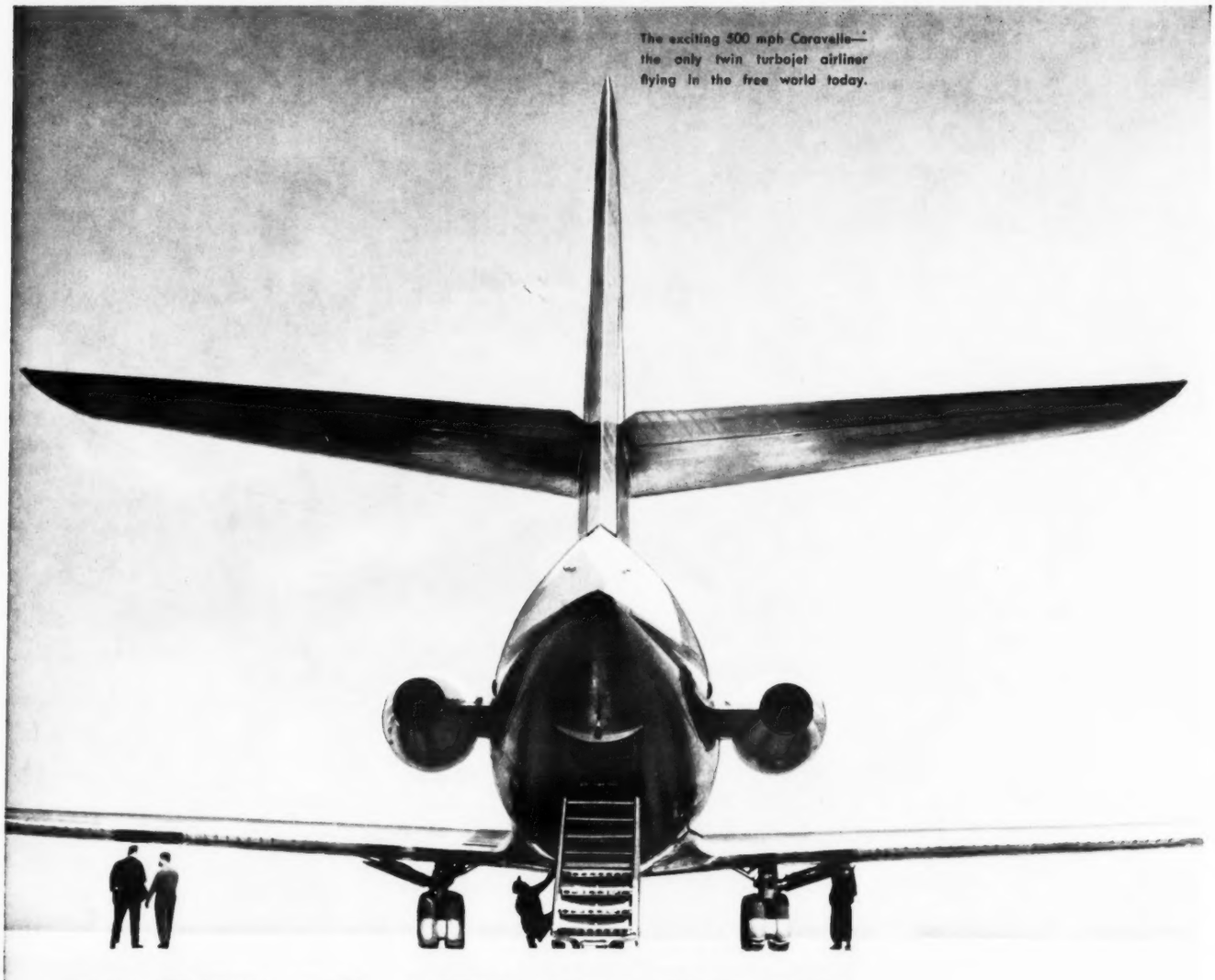

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